THURSDAY, FEBRUARY 26, 1920.

METEOROLOGY AND THE STATE.

DURING the war, meteorology, like many other branches of science, was utilised to an unexpected extent, and its importance has thereby gained recognition in far wider circles than might otherwise have been the case. The rapid development of aviation has contributed to this, for accurate forecasts and a knowledge of the conditions prevailing in the upper air are of the greatest importance to the airman, and the subject now forms a part of his course of instruction.

With the cessation of hostilities, the Meteorological Office has had to consider the reconstruction which would be necessary in its organisation to meet the larger demands made upon it, and to maintain the expansion and development of the scientific side of the subject which such increased activity demanded. In other countries the meteorological service has always been part of one of the Departments of State, but in this country its status has varied from time to time. The Meteorological Office began in 1854 as a Department of the Board of Trade for the purpose of collecting information about the meteorology of the sea, to which was added later the study of forecasting. Later, it was placed under a committee appointed by the Royal Society, which administered the funds furnished by an annual grant-in-aid. Since 1905 the Office has been under the management of a Committee appointed by the Treasury, and consisting of representatives of the Admiralty, Board of Trade, Board of Agriculture and Fisheries, and the Royal Society. Thus the Meteorological Office has for many years been a service mainly supported by State funds, but not attached to any Department, its policy being determined by the Committee responsible for its administration.

Under these conditions much valuable scientific work has been done, and, whatever the advantages of such an independent position may have been, the greatly increased utilisation of meteorological information by various Departments of State has recently brought the status of the Meteorological Office under consideration.

In the report of the Meteorological Committee for the year ending March 31, 1919, a proposal of the Air Ministry made in the spring of 1918 to take over the Office, on account of the importance of meteorology to aviation and of the use of aviation to meteorology, is presented; but no definite action was taken at the time. Later in the year a Committee of the Cabinet was in favour of transferring the meteorological service to the Department of Scientific and Industrial Research, with a view to the co-ordination of the various meteorological services then existing. Such a scheme appeared to afford a satisfactory means of meeting the requirements of the Departments, and also of maintaining the scientific research essential to advance in meteorology.

Since then it has been announced by the Under-Secretary of State for Air that the Cabinet has decided that the Meteorological Office should be attached to the Air Ministry, and the amalgamation of the staff of the Meteorological Office with that of the Meteorological Service of the Air Ministry is understood to be in course of execution. We may therefore conclude that the importance of the State Meteorological Service to the modern needs of the fighting Services, as well as to the other Departments of State, is such as to render its closer connection with them desirable, and apparently the special needs of the Air Ministry and its exceptional facilities for obtaining information from the upper regions of the atmosphere have led to its selection as the Ministry to which the Meteorological Office should be attached.

Such recognition of the importance of meteorological science, and the co-ordination of different services dealing with the subject, are to be welcomed, but men of science will wish to see the freedom for investigation and research which has been a special feature of the Office under its former committees of management fully maintained under the new conditions arising from its re-incorporation in a State Department. Some misgivings on this point seem to exist, for the council of the Royal Meteorological Society, in a resolution published elsewhere in this issue, while recognising the advantages which the Meteorological Office may gain from a closer association with the Air Ministry, suggests that there may be a tendency for certain branches of meteorology to be relegated to a subordinate position of importance if the management of the Service rests with a single Department having special interests of its own.

Here we meet the difficulty of reconciling the advantages gained from the support and resources of an influential Ministry with such restrictions as are inseparable from the administration of a large Service. The special interests and requirements of a controlling Department will naturally appeal more strongly to its administrators, and proposals for expenditure on schemes will gain more sympathy and support than others with which they

are less familiar. Such considerations probably influenced the Meteorological Committee in concurring in the proposal for transference to the Department of Scientific and Industrial Research.

But, since the incorporation of the Meteorological Office in a State Department is necessary, as seems to be generally agreed, the important matter is how advance in all branches of the subject may be assured. Besides forecasts of the weather and information concerning conditions in the upper air which especially affect the Air Ministry, there are the needs of the Navy, the mercantile marine, and the shipping community in general; the interests of farmers, foresters, and fruit-growers; the requirements of water engineers, river conservancies, and many other branches of the community. The War Office has special demands of its own in connection with gunnery, sound-ranging, etc., and there are many questions coming within the scope of the Ministry of Health and other Government Departments which utilise meteorological information. For all these lines of work, scientific investigation must be carried on continuously in order to obtain fuller knowledge of the atmospheric processes which can be utilised to the advantage of the various interests which have been mentioned. To this end observatories are maintained for investigation apart from their utility as reporting stations, and it is of the utmost importance that such scientific research should be continued and afforded full freedom of action.

With its transfer to the Air Ministry, the Meteorological Office has gained a large addition to its staff, and with its extended network of reporting stations its budgetary provision in the coming financial year will doubtless be greatly increased. The State Service is still almost the only one offering a career to a man who is attracted to the subject of meteorology, and if those of the best ability are to be obtained, it is essential that scientific research in it should be encouraged in which their powers may be utilised. No announcement has so far been made of the constitution of the Committee which continues the work of the Meteorological Committee, or of its powers and responsibilities, but it is to be hoped that science will be strongly represented on such a Committee which can advise the Air Ministry on the best policy to be pursued for the advancement of meteorological science, and will be empowered to direct the execution of such policy. By this means the Ministry will be assured that research will be carried on most efficiently and to the advantage of all branches of the subject.

THE BIRTH OF OCEANOGRAPHY.

Accounts Rendered of Work Done and Things Seen. By J. Y. Buchanan. Pp. lvii + 435 + 3 plates. (Cambridge: At the University Press, 1919.) Price 21*s.* net.

MR. J. Y. BUCHANAN has passed the allotted span of years, but we who are no longer young cannot call him old. Yet he was hard at work in a generation which has all but passed away, and his recollection reaches back to things which are but a tradition to the most of us. He is the last of that happy band who set sail from Portsmouth in the *Challenger* under Wyville Thomson just seven-and-forty years ago; he was born in another world than ours, when (as he tells us) the only railways on the Continent ran, as kings' playthings, from Paris to Versailles, from Berlin to Potsdam, from Hanover to Herrenshausen. Now in this volume, as in one before, he has "rendered his accounts" (but only partially) of the abundant work he has done and the countless things he has seen. The book contains essays both great and small, from letters to NATURE to addresses delivered to universities and learned societies, and the things of which these papers treat are both big and little, for Mr. Buchanan has kept a sharp look-out, conning everything—from the rats in a Bordighera garden (which left the oranges alone, ate the rind of lemons and left the fruit, ate the fruit of mandarins and left the rind) to the great panoramas of earth and sea which for so many years have passed before him.

Most of the papers deal (as we should expect) with matters oceanographical, such as the temperature of the sea, its colour, its saltness, or the manganese and other nodules lying in its bed. The treatment is in great measure new, or was so when the papers were written; but the themes are old—and are made all the more attractive thereby. One is reminded of Robert Boyle's "Observationes de salsedine maris," or, again, of the "Histoire Physique de la Mer"—based upon so little, because it was all there was—of that exquisite writer and gallant soldier of fortune, Louis Ferdinand, Comte de Marsilli. Even one or two names like these (and we do not forget Captain Maury, another great captain and soldier of fortune) make us hesitate a little to accept Mr. Buchanan's account of "The Birthday of Oceanography." And yet perhaps he is not very far wrong to persuade us that that science was born, a little to the westward of Teneriffe, on February 15, 1873. For this was the day when the *Challenger* made her first oceanic sounding; and, immediately after, the dredge came up full of new and strange things,

great corals, huge siliceous sponges, and what not more—first-fruits of the noble harvest to be gathered from the "Depths of the Sea."

In some things, and again it is no wonder, Mr. Buchanan prefers the old times to the new. He tells us of the cool comfort of an old wooden ship, its perfect fitness for the work of exploration, and how we have no ships nowadays like the *Challenger*. We are half-tempted to agree with him. He commends, even with enthusiasm, the old-fashioned hempen dredge-rope and sounding-line, and assures us that "wire is the very emblem of treachery." In later years, when wire had come into use, he says: "I never attached a thermometer to the wire without feeling that I was guilty of a form of cruelty—cruelty to instruments." This is a much harder saying—to those of us who have used nothing else; let us hope that it is the wire which has altered, and not the men.

It need scarcely be said that this book is well worth reading. It has many pages to interest even the man in the street, and has both an historical interest and something more besides for the present-day student of oceanography. In these seven-and-forty years methods have been refined, new theories and concepts formed; but we do not forget that birthday party on board the *Challenger*, nor Mr. J. Y. Buchanan, who is the last of the godfathers.

D'ARCY W. THOMPSON.

INDUSTRIAL PSYCHOLOGY.

Lectures on Industrial Psychology. By Bernard Muscio. Second edition, revised. (Efficiency Books.) Pp. iv+300. (London: George Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., 1920.) Price 6*s.* 6*d.* net.

THIS book is founded on a course of five lectures which were delivered before a general audience at Sydney University, but they must have been considerably expanded when put into book form. The author does not lay claim to have made any first-hand investigations on the problems with which he deals, but the book is very far from being a mere compilation. It shows throughout a deep insight into the principles of industrial psychology, and is especially lucid on the much-debated question of scientific management.

Mr. Muscio takes in turn the various objections to this system raised by the workers themselves, and with great ingenuity tracks down the true inwardness of these objections, and discusses the manner in which they may be overcome. He maintains that the main fact to be insisted on is that the new methods prevent waste of human energy, and render it possible to obtain a given output from a much smaller expenditure of human energy than that hitherto found necessary. Labour's objection that the general introduction of scientific management would cause widespread unemployment applies equally to every improvement introduced into industry in the past. The difficulty can be largely overcome by installing the improvements gradually and absorbing the surplus workers by the simultaneous introduction of other forms of labour.

Again, Labour maintains that scientific management leads to undue speeding up. There is much truth in this assertion, but the difficulty can be overcome by the introduction of longer intervals of rest and by shortening the working day. Other objections to the system could be avoided by arranging for an adequate system of industrial education. The employer and employee must co-operate in the introduction of a scheme whereby no time study of an operation shall be made, and no bonus system adopted, without the consent of the worker.

A very interesting and important field of industrial psychology centres around vocational selection. This subject is discussed at length by the author, and concrete instances of the methods as applied to the selection of telephone girls and electric-street-car drivers are described in detail. Industrial fatigue is treated rather briefly, and is the least satisfactory part of the book, as the information adduced is largely out of date. That concerning industrial accidents is fragmentary and misleading, and no reference is made to the "safety first" campaign, and to the effects of suggestion on the avoidance of accidents. The lectures were apparently written in 1916, and the author has endeavoured to bring them up to date in this revised edition by the somewhat irritating and unsatisfactory method of appending footnotes.

H. M. V.

CRIMINOLOGY AND NERVOUSNESS.

(1) *Criminology.* By Dr. Maurice Parmelee. Pp. xiii+522. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1918.) Price 10*s.* 6*d.* net.

(2) *The Mastery of Nervousness based upon Self-Re-education.* By Dr. Robert S. Carroll. Third revised edition. Pp. 348. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1918.) Price 10*s.* 6*d.* net.

(1) DR. PARMELEE has written a very readable book on the various aspects of crime and criminals. He has disclosed nothing that is

altogether new, but he has brought together and discussed the varied factors of a large subject in a lucid and interesting way. He begins with a consideration of the evolution of crime, and then discusses in some detail the part played by environment. In part iii. the subject of the organic and the mental basis of criminality is taken up, together with the classification of criminals and the problems of juvenile and female criminality. Part iv. deals with criminal jurisprudence, and part v. with a discussion of penology. The final section comprises a study of the problems of political crime and the crimes arising from opposition to the fixity of social custom, with a chapter on prevention.

Two appendices are added, one dealing with the relation between the price of cereals and crimes against property, and the other—of revived interest at the present time—a criticism of the late Dr. Charles Goring's book, "The English Criminal," which appeared in 1913.

Dr. Goring is taken very pointedly to task for misrepresenting Lombroso "grossly and inexcusably," for his "gross misrepresentation" of the author of "Criminology," and for his ignorance of psychology—although we must confess we think several of Dr. Parmelee's beliefs, such as the physiological theory of instinct, the James-Lange theory of emotion, and his belief in the efficacy of ideomotor action, are not the most fruitful that could be applied to the elucidation of his subject. Finally, he condemns Dr. Goring's researches as carrying the statistical method too far, and concludes that, in spite of his initial disagreement with Lombroso, Dr. Goring has proved himself "more Lombrosian than Lombroso himself."

The author's aim, as he states, has been to make a more or less comprehensive survey of criminology, and that he has succeeded admirably no one who reads his book will doubt.

(2) "The Mastery of Nervousness" is a zealous book, a volume not only of medical, but also of ethical, instruction, a guide, philosopher, and friend to the nervous, but chiefly the last. The aim has not been the exposition of any narrow or restricted doctrine; there are, consequently, a freedom of style and treatment and a command of metaphorical expression which are certainly stimulating and doubtless of benefit to many.

The author points out the growing prevalence of nervousness—that is, overactive or misdirected nervous activity—and describes the influence of various factors—heredity, diet, inactivity, work, play, and others. On "Mastery through Work" he writes: "It is a profound misfortune for any young person to enter the serious years of life without having been earnestly impressed with the dignity of work, or taught to feel that ever within reach are divinely appointed duties."

Dr. Carroll lays emphasis on the importance of the early years of life. "Loss," he writes in the chapter on "Surrender," "begins in childhood. The babe is king of us all. The grim visage of the warrior softens in the presence of its cooing innocence; nobility stops and turns, and does homage; rich and poor, high and low, young and old, kneel at the cradle to welcome the bright, new, young soul."

In the same chapter is a picturesque example of sublimation or "side-tracking," which describes how a patient worked her "jim-jams" off in the garden by "vicious jabs into the soil with hoe and spade"—a species of horticultural profanity that brought back memories of France and the impressive language of the trenches, which, we know, performed an equally estimable function.

The theme of treatment is efficiency through harmony. "If we are to win the battle of personal mastery we must lay hold on a force higher than reason alone, for force of mind not governed by force of spirit does not make man good." The great necessity, the author says, is for "ultimate control of the moral idea, as the only force resolving the dissonance of jangling nerves into harmony."

PRACTICAL CHEMISTRY.

(1) *Elementary Practical Chemistry.* Part i. *General Chemistry.* By Prof. Frank Clowes and J. Bernard Coleman. Seventh edition. Pp. xvi+241. (London: J. and A. Churchill, 1920.) Price 6*s.*

(2) *A Treatise on Qualitative Analysis: Adapted for Use in the Laboratories of Colleges and Technical Institutes.* By Prof. Frank Clowes and J. Bernard Coleman. Ninth edition. Pp. xvi+400. (London: J. and A. Churchill, 1920.) Price 12*s.* 6*d.*

THERE are two distinct aims that may actuate the writer of a text-book on practical chemistry, whether analytical or otherwise, namely, (1) the setting forth of principles, and (2) the enumeration of facts. To a certain extent they are inseparable, for principles without facts are useless, and facts without principles are not ordered knowledge. But it is impossible to make the best of both at the same time. If the principles are burdened with too great a multiplicity of facts, they are fairly certain to be smothered by them, and facts cannot be set forth in the clearest possible way if the method of arranging them is to serve some other end as well.

(1) "Elementary Practical Chemistry" is now, for

the convenience of students, divided into two volumes, of which the "General Chemistry" is the first, leaving "Analytical Chemistry" to the second. The volume before us deals with the principles of chemistry, and gives a series of more than 300 experiments in illustration of them. The text is sufficient to show the bearing of the experiments, in addition to the instructions for the performance of them, but it is presumed that a course of lectures dealing more fully with the subject will be given concurrently with the practical work.

(2) The "Treatise on Qualitative Analysis" has, in the present edition, been "rewritten, recast, and enlarged in order to adapt it to modern methods of teaching." It is essentially a book of facts, for it treats of the detection of the rarer as well as the more common metals and acids, a considerable number of organic acids both aliphatic and aromatic, a few hydrocarbons, halogen, nitro- and other derivatives, alcohols, ethers, aldehydes, ketones, carbohydrates, glucosides, organic bases, eighteen alkaloids, and finally nineteen different gases. In addition to all this there are instructions for making stirring rods, boring corks, etc., for performing various operations, such as precipitation, filtration, washing, and drying, and as to the use of the spectroscope, a description of laboratory fittings, recovery of residues, lists of reagents, and various tables. There is also a small section which gives lists of simple salts, mixtures, and minerals suitable for practice, though these do not include organic substances, the rarer elements, or gases. Thus teachers, as well as students in all stages of their work, will find assistance in this volume.

It is curious how long a time it takes for some facts of first importance to work their way into text-books that are written for students. It has been known for more than fifty years that manganous chloride, when introduced into a flame in the ordinary manner, colours it brightly green, but scarcely any text-books note the fact. We have known students to be led astray by this omission. The authors here state definitely that the compounds of the metals Zn, Mn, Ni, and Co show no characteristic flame colorations, and in the tables a green flame is followed by the inference —Ba, Cu, B_2O_3, exactly as in almost every text-book on the subject. There is a tendency to be more "theoretical" than practical in the statement that ammonium carbonate and nitrate are decomposed by heat into gases, and "they are therefore volatilised without producing white fumes or a sublimate."

The full instructions in the tables, and the very large number of notes appended to them, are evidence of the care taken by the authors, and the many editions that have been issued show that this care is appreciated, and it is deservedly so, by those for whose use the book is intended.

C. J.

A MATHEMATICIAN'S MISCELLANY.

Pensées sur la Science, la Guerre et sur des Sujets très Variés. By Dr. Maurice Lecat. Pp. vii + 478. (Bruxelles: Maurice Lamertin, 1919.)

M. LECAT is a great reader with catholic tastes. For twenty years he has been in the habit of copying out all the passages that have struck him in the reading which occupies his leisure. He has now, at the instance of a friend, collected and arranged them in a volume of 480 pages of double columns. There are about 11,000 extracts from some 1500 authors grouped under subject headings. The first 1200 refer to various branches of science and its most distinguished exponents. The remainder, dealing with every possible subject, grave and gay, of topical or perennial interest, come under titles arranged alphabetically; we proceed in due order from Abstraction, Abus, . . . Allemagne (the longest section), to Voltaire, Voyage, Yeux, Zola. The quotations, whatever the language of their origin, are usually, but not always, translated into French. The whole is furnished with two elaborate indexes and the dignity of an appendix.

The industry that has produced the book is amazing—so amazing that it is surprising that obvious slips should have been allowed to pass in the information concerning authors. A reviewer who should take the opportunity it affords for ridicule would lack even that small portion of humanity usually allotted to his kind. But we fear that M. Lecat is too optimistic in his hope that his collection will serve as an instrument of intellectual research by providing a compendium of the best thought of mankind. In both selection and arrangement such a work inevitably bears the impress of the editor. No one man, even with the voracity of M. Lecat, can consume all literature; the portion that he can digest is infinitesimal. Though writers of at least eight languages are included, ranging from David (the son of Jesse) to Max Harden, and from Homer to the *Morning Post*, it is only natural that those who have used the French language should have the preponderance. Nor do our author's wide interests and his passionate plea for impartiality enable him to conceal from his readers that he is a Belgian, a good son of the Church, and a mathematician. Even if he had been able to avoid the exclamatory "sic!", his best efforts

would still have left those whom he addresses with the impression that they are studying, not the sifted wisdom of the ages, but the opinions of M. Maurice Lecat.

However, the subsidiary claim that he makes may be heartily supported. It is a most entertaining volume to dip into for a few moments to pass the time. If it were only rather handier, and the type a little larger, it would be ideal for the bedside. As it is, perhaps the dentist's waiting-room provides for it the proper sphere of usefulness.

N. R. C.

OUR BOOKSHELF.

Penrose's Annual. Vol. xxii. of "The Process Year Book." Edited by William Gamble. Pp. x+112+plates. (London: Percy Lund, Humphries, and Co., Ltd., 1920.) Price 10*s.* 6*d.* net.

OUR special congratulations are due to the editor and publishers of this ever-welcome annual that, after an interval of three years, they have been able to resume its issue. The editor, as usual, in his "Foreword" reviews the recent advances and the present condition of the reproductive graphic arts. In the circumstances one could scarcely expect anything strikingly new, but we are told that one bright and hopeful feature of the present is that work is now being adequately paid for, and that as a consequence employers are able to give satisfying wages as well as to improve their plants. Photo-lithography is coming more and more into use. Collotype is "coming into its own again, thanks to the absence of German competition." The collotype work now being done in this country is of excellent quality, and probably greater in quantity than ever before. Half-tone and three-colour work stand pretty much where they were before the war, while rotary photogravure is coming increasingly to the front for newspaper and periodical work. It is now quite practicable to print both text and illustrations together by this last process, and there are signs that before very long type-setting may be rendered unnecessary. Two American journals have already been produced without the aid of the compositor. The volume contains articles from the pens of many contributors, and is very rich in illustrations of all kinds.

C. J.

The Occlusion of Gases by Metals: A General Discussion held by the Faraday Society, November, 1918. (Reprinted from the Transactions of the Faraday Society, vol. xiv., parts 2 and 3, 1919.) Pp. 93. (London: The Faraday Society, n.d.) Price 8*s.* 6*d.*

THIS volume contains a record of another of the valuable symposia held by the Faraday Society. The subject of the gases retained by solid metals bears on a number of technical processes, so that the papers contributed cover a wide range. Sir Robert Hadfield's introduction gives a useful summary of the knowledge of the gases in iron and steel, with a bibliography. The theoretical aspects are dealt with by Profs. Porter and McBain, the well-known case of the absorption of hydrogen by palladium receiving attention, whilst Dr. McCance's paper on balanced reactions in steel manufacture discusses the question of the equilibria in the steel furnace which determine the proportions of the various gases which will be in contact with the metal at the time of tapping. The view that the amorphous phase in solid metals is responsible for much of the dissolved gas is maintained by several of the contributors, but no evidence is adduced to prove that gases are insoluble in crystals of pure metals. The fact that the solubility of gases in molten metals increases with the temperature has often seemed remarkable, but Prof. Wilsmore points out that this is probably the normal behaviour, water being exceptional in its diminished solvent power for gases with increasing temperature. The discussion contains much that is of interest both to metallurgists and to physical chemists.

C. H. D.

Examples in Heat and Heat Engines. By T. Peel. Pp. iii+104. (Cambridge: At the University Press, 1919.) Price 5*s.* net.

THE working of exercises forms a very important part of the course work of an engineering student. Many of the exercises required for the purpose of elucidating the subject of heat and heat engines can easily be made up; on the other hand, there are many important facts which can be illustrated only by exercises containing as data observations made during experiments. Teachers and students will welcome the book before us, because, among numerous other exercises, there is a large number giving experimental data on steam, gas, and oil engines, steam boilers and turbines, refrigerators, and calorimetric work. It is true that the best data for exercise working are those obtained by the student in experiments carried out by himself. Since most heat and heat-engine tests take a rather long time to carry out, the amount of information thus accumulated in the case of any one student can have only a limited scope, and the excellent exercises contained in the book will make a very useful supplement.

The Hill of Vision: A Forecast of the Great War and of Social Revolution with the Coming of the New Race. Gathered from Automatic Writings obtained between 1909 *and* 1912, *and also, in* 1918, *through the Hand of John Alleyne under the Supervision of the Author.* By Frederick Bligh Bond. Pp. xxv+134. (London: Constable and Co., 1919.) Price 7*s.* 6*d.* net.

THIS book is a sequel to "The Gate of Remembrance," which contained an account of the automatic script giving instructions for excavations in Glastonbury. The further script now published deals with the war and after, but it cannot be said that the correspondences and verifications of predictions pointed out are particularly striking or convincing.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Organisation of Scientific Work.

I TRUST the rank and file of scientific investigators throughout the Empire will wake up to the urgent need of combined energetic action. The proposals to centralise under the control of a few official departmental heads the body of actual scientific investigators in India, thus creating a few highly paid administrative posts for senior men and effectually killing all initiative, enthusiasm, and liberty of action on the part of those actually carrying on the investigations, is perfectly in accord with what has happened in this country since, in an evil day, the Government assumed the control of scientific and industrial research. It is a proposal that appeals, naturally, to the official without knowledge of the way in which scientific discoveries originate, and anxious to secure a body of cheap and docile labour, even though it be mediocre in calibre, and to those few who hope to secure for themselves these senior lucrative administrative posts. To genuine investigators such posts, however highly paid, would be unattractive, and under such a system there seems every inducement for men of originality and scientific ability to give the service a wide berth. Whereas the crying need in India, as everywhere, is for men of high calibre and honest, independent mental outlook, anxious only to secure favourable conditions under which they may be left free to pursue their creative work, and, this being secured, careless of wealth, rank, and power save as the necessary antecedents to the essential condition.

Two assertions, which can be made without the slightest fear of contradiction, may be put into juxtaposition in order to contrast the remedy proposed with the state of things it is desired to cure. First, that of all great nations the British Empire has most signally failed in its application of scientific knowledge and methods to its national problems; and, secondly, that in the British Empire there exists a body of skilled and hard-working scientific investigators second to none, and, even under the most disheartening conditions, actually enlarging the boundaries of natural knowledge in no mean degree. As the great schemes for rectifying matters crystallise into action, with the formation of a Department of Scientific and Industrial Research at home and concrete proposals for action, as in the Indian reorganisation suggested, more and more they seem to amount to this: The men who do the work, and against whom no fault is alleged, are to be deprived even of what little satisfaction and independence genuine scientific work for its own sake affords, and are to be put under the men against whose incompetence and lack of knowledge the whole uproar originally arose. In research, where, as the leading article in NATURE of February 19 so truly says, the man is everything, that man is to be put under men who brought an Empire, as rich in scientific talent and genius as any, perilously low. The remedy, surely, is to put the incompetent machine under the charge of competent men, not *vice versa*.

Our *soi-disant* scientific representatives seem still in the stage once lived through in our ancient universities, where it was at one time deemed politic that any scientific demand, if it were to pass, should be put up and seconded by well-known opponents of science, thus, on the chance of securing a temporary advance, permanently sacrificing the whole future. That we did not in 1914–19 repeat the medical horrors of the Boer War, when more died of pestilence than at the hands of the foe, is surely due to the emancipation in the interval of the Army medical services from non-qualified misdirection. That our food control during war-time was successful, even by comparison with that of more favourably situated belligerents, was because scientific men were from the first in charge of its scientific aspects—a rare condition, due probably to so many of them belonging to the profession that exacts due and proper respect for its members. Can one imagine young medical graduates, after a prolonged and serious university training, being sent up, as our scientific graduates were sent, hauling about gas cylinders with the rank of corporal? Can one imagine a director of a medical research association a foreign business man or manufacturer unknown to the research world? Can one imagine a proposal for State aid for medical research being dismissed by an unqualified person so ignorant of the history of scientific discovery as to deem it sufficient to dub the proposal as a "floating research" in order in his own eyes to condemn it? Neither can I imagine such happening in the scientific world if its leaders were equally alive.

Ordinary people, benevolent to science and unfamiliar with affairs, often wonder why scientific men are so powerless and peculiarly unable to protect themselves and to advance their subjects to a position commensurate with their national importance. The answer is to be found, I think, in the obsolete character of their so-called representative societies. Year after year in the chief of these the councils nominate and elect themselves without any reference to their members except for formal ratification. Through sheer lack of backbone and being out of contact with the body of their members, time and again they sacrifice interests vital to the continued existence of genuine scientific research. I do not wish to advocate for scientific investigators a close corporation keeping lynx-eyed vigil over their professional interests and seeking every opportunity to enlarge and consolidate them, identical with other learned professions; for the paramount interest of a scientific investigator should be his work, and his privileges, emoluments, and status are to be regarded merely as means necessary to secure opportunity and power *to do it*. That should be the test of these schemes, and not the further subordination of the men who do the work to the organisation attempting to get the work done. But unless they band together and take action, the rank and file of research workers throughout the Empire will not even be able to retain the miserable position they occupied before the war in the national life, and their interests will continue to be sacrificed to the ambitions and love of power of the few. FREDERICK SODDY.

THE "Notes" columns of NATURE for February 19 contained a reference to a suggested conference between British botanists at home and overseas at which matters of common interest would be discussed. From some preliminary correspondence which had taken place in order to ascertain the feeling of our colleagues overseas as to the prospects of success of such a conference some interesting communications were received, especially from India, which bear on the subject of the organisation of scientific work. It was urged that this should form a subject for discussion in the event of a conference taking place, and it was evident that the writers were strongly opposed to a policy of centralisation. On the contrary, they were seeking greater freedom in their scientific work, and their communications hinted at irritating restrictions and disastrous results due to official interference—effects which would be much

enhanced by such a scheme of centralisation as was indicated in the leading article in the same issue of NATURE. There may have been some waste of effort in the past, both at home and overseas, owing to insufficient co-operation between men of science working independently, but this is a matter for workers to set right among themselves, and will not be mended by an organisation conceived on the lines of a German military system. Further, it is unlikely that the best men will be attracted to work under such deadening conditions.

Care must be taken that public money is not wasted in scientific development, but the kind of official control suggested by a scheme of centralisation does not commend itself as an efficient waste-preventer. Grants of money to scientific societies or institutions might be administered by carefully selected boards of trustees, the scientific work being left to the unhampered initiative of the scientific staff under a head specially suited to the character of the work. The management of our Natural History Museum, a Government institution, is invested in trustees, who leave to the scientific staff the carrying out of the scientific work as effectively as funds and opportunity allow. Research work of the highest value to agriculture is being carried out at the Rothamsted Experimental Station, the original endowment of which has been generously supplemented by private munificence and by Government grants. Here also the management is vested in a small committee the members of which represent the various scientific sides of the work carried on.

A. B. RENDLE.

British Museum (Natural History).

Gravitational Deflection of High-speed Particles.

THE investigation of the consequences of Einstein's law as regards the motion of a material particle moving through a gravitational field with a velocity comparable to that of light brings out some interesting and rather surprising effects. As Einstein's law is entirely kinematical, involving accelerations instead of forces, no account need be taken of variation of mass with velocity other than that contained in the law itself. Let m denote the mass of the attracting body (*i.e.* the sun) in astronomical units divided by the square of the velocity of light. Then the motion of a particle in the field produced by this body is determined by

$$\delta\int\sqrt{\left(1+2\frac{m}{r}\right)\left(dr^2+r^2d\theta^2\right)-\left(1-2\frac{m}{r}\right)c^2dt^2}=0,$$

the $r\theta$ plane being that of the orbit. From the Lagrangian equations corresponding to this Hamiltonian statement of the law, the energy relation

$$\frac{1}{2}\frac{d}{dt}(v^2)=-\frac{mc^2}{r^2}\left(1-4\frac{m}{r}\right)\dot{r}=3\frac{m}{r^2}v^2\dot{r}$$

is obtained. If the velocity of the moving particle is comparable to the velocity c of light, the second term in the parenthesis on the right-hand side may be omitted as negligible compared to the last term. The resulting approximate equation is easily integrated, leading to the expression

$$v^2=c^2\left\{a^2\left(1-6\frac{m}{r}\right)+2\frac{m}{r}\right\},$$

where a is the ratio of the velocity of the particle at infinity to that of light.

Consider a particle the velocity of which at infinity is negligibly small compared to that of light. Then the factor a is small, and the second term in the parenthesis which it multiplies may be omitted. This gives the energy equation of the Newtonian theory.

If, however, the particle has a high velocity, the omitted term becomes of importance. In fact, when the velocity is $1/\sqrt{3}c$, this term has the same value as the third term, but the opposite sign. Therefore, these two terms annul each other, and the velocity of the moving particle is unaffected *in magnitude* by the gravitational field. In other words, the *tangential* acceleration of the particle is zero throughout the course of its motion through the field. If it were headed directly for the attracting centre, it would move along in a straight line with constant speed just as if no field were present.

Next, consider a particle having a velocity at infinity greater than $1/\sqrt{3}c$. The velocity of this particle is actually decreased by the gravitational field. If it were aimed straight at the attracting mass, it would be slowed down just as if it were *repelled* with a force varying inversely with the square of the distance. If the velocity of the particle at infinity is equal to that of light, its velocity decreases as it approaches the centre of attraction in the same amount as that of a light-wave, for Einstein's theory makes no distinction between material particles and electromagnetic disturbances.

Consider a particle moving along the X axis with a high velocity v. Let the attracting mass m be on the Y axis, a distance R below the origin. Then the components of the particle's acceleration are

$$f_x=-\frac{mx}{r^3}\left(c^2-3v^2\right),$$

$$f_y=-\frac{m\mathrm{R}}{r^3}\left(c^2-v^2\right).$$

If the particle's velocity is greater than $1/\sqrt{3}c$, the tangential component f_x is positive, and the particle is slowed down as it approaches the centre of the field. The normal component f_y, however, causes the particle to be deflected towards the gravitating mass for all velocities less than c. This deflecting acceleration becomes less, however, as the velocity increases, and a particle moving with the velocity of light would travel through a gravitational field in a straight line. Its velocity, however, decreases as it approaches the gravitating centre, and then increases as it recedes from this point. For velocities close to that of light the deflection is given by

$$2\frac{m}{\mathrm{R}}\left(\frac{c^2-v^2}{v^2}\right).$$

The deflection suffered by a light-wave is of a nature quite different from that experienced by a material particle. A ray of light is not bent towards the sun by the latter's gravitational attraction, but the velocity of that portion of the wave-front closest to the sun is decreased more than that of the more remote portion. Therefore, the wave-front is swung round in exactly the same way as when light passes obliquely from a rarer to a denser refracting medium.

In conclusion, it may be noted that the two consequences of Einstein's law which are of great enough magnitude to be tested experimentally have been most conspicuously verified. The predicted shift of the Fraunhofer lines towards the red does not seem to be a necessary consequence either of Einstein's law or of the part of the theory on which this law is based, but rests on the very doubtful assumption that the system of a freely moving atom near the sun's surface is identical with that of a freely moving atom 93,000,000 miles away. If space-time had the same properties in

the two regions this identity would be required by symmetry, but as the warping of space-time is quite different near the sun from what it is at the distance of the earth, does it follow that these two systems are necessarily equivalent? It does not seem to the writer that the failure to find this shift invalidates the part of Einstein's theory from which his law of gravitation is deduced, and it certainly does not contradict this law itself.

LEIGH PAGE.

Sloane Laboratory, Yale University, New Haven, Connecticut, January 22.

Biological Science in Secondary Schools.

I SHOULD like to direct attention to a very important paragraph in the Report of the Investigators of the Secondary School Examinations Council which is not referred to in the article which appeared in NATURE of February 19 (p. 669). It is the paragraph which deals with natural history and zoology.

It is quite clear from this paragraph that the Investigators wish to discourage the teaching of the animal side of biology in secondary schools—a very serious matter in itself. But when the Investigators proceed to state that "the principles of biological science can be [better] illustrated by means of botany," they are expounding a doctrine as to the teaching of a science which is bound to have most serious and harmful results.

The principles of biological science can be taught or illustrated only by persons with a competent knowledge of both botany and zoology, and a suggestion such as this, issued as the considered judgment of a body of educationists, that a knowledge of botany alone is sufficient for this purpose, will only exaggerate the present-day incompetence of the teaching of biology in many of our secondary schools, in which the teachers have had no training in zoology. This matter has already been considered by a representative meeting of zoologists in London, and steps are being taken to represent the views of zoologists to the President of the Board of Education at an early date.

SYDNEY J. HICKSON.

The Victoria University of Manchester, February 23.

Change of Colour in Captive Birds.

MR. HAROLD MILLAR invites notes on this subject (NATURE, February 5, p. 600). The case of the crossbill (*Loxia curvirostra*, Linn.) seems in point. My attention was directed to it some years ago, when I saw a number of crossbills—six or eight, if I remember aright—confined in a large cage or small aviary at Glenferness, Nairnshire. The brilliant scarlet plumage which distinguishes the adult male in a state of freedom had changed on these captives to yellowish-olive, and I was informed that this was the invariable effect of captivity. The late Lord Lilford kept a number of crossbills in his famous aviary, and has the following note in his *coloured* "Figures of Birds of the British Isles":—

"On the vexed question of the plumage of the crossbill, I can only say that every *red* bird that I ever possessed lost that brilliant colour at the first moult, and never regained it" (vol. iv., p. 76).

In all the stuffed specimens that I remember to have seen the scarlet hue had faded to the same dingy olive.

HERBERT MAXWELL.

Monreith.

Volcanic Rocks in Northern Kordofan, Sudan.

IN view of the discovery of the Bayuda volcanic field observed by Dr. Chalmers Mitchell during the *Times* African flight, and referred to by Prof. J. W. Gregory in NATURE of February 19, some interest attaches to a specimen of a volcanic rock sent to the Mineral Department of the British Museum for identification in July, 1912, by Dr. C. G. Seligmann. The specimen was collected by Dr. Seligmann at the base of Jebel Katul, Northern Kordofan, where he found many stone implements made of the same rock.

Jebel Katul is 350 miles south-west of the volcanic field seen by Dr. Chalmers Mitchell, and is on the trend of the north-east to south-west depression indicated by Prof. Gregory as running from the coast of the Red Sea south of Adal Qaqa, and following the course of the Nile from Abu Hamed to Korti.

The rock is very fine-grained and slate-blue in colour, weathering to pale green. Examination shows it to be a riebeckite-rhyolite showing "flow structure," but too fine in grain to enable the nature of the felspar or the relative amounts of quartz present to be determined. The rock is nearly allied to the riebeckite-rhyolites of Gilgil, north of Lake Naivasha, and to the riebeckite-bearing trachytes of Senafé and Fakoda, North Abyssinia, described by Dr. G. T. Prior in 1903, both of which occurrences are on the line of the Great Rift Valley.

W. CAMPBELL SMITH.

Mineral Department, British Museum (Natural History), Cromwell Road, S.W., February 23.

Scientific Workers and a National Federation.

CONSIDERABLE misapprehension seems to have arisen with regard to the action taken by the National Union of Scientific Workers in connection with the inaugural Conference of Professional Associations on February 7, convened for the purpose of forming a National Federation of Professional, Technical, Administrative, and Supervisory Workers. I shall be glad if you will give publicity to the following statement of fact:

This union was invited to send delegates to the inaugural conference and accepted the invitation, as there were many other technical and scientific associations invited with which it was felt this union had almost identical interests. As the result of the preliminary discussion, it was found that such bodies as this would be out-voted and out-influenced in any such federation by unions with which it has little in common. With the help of other associations we moved an amendment in an attempt to prevent the new federation from taking a definite bias at its inception. This amendment was lost, whereupon we abstained from taking further part in the proceedings.

The report as it appeared in the Press stated that the resolution to form a federation was carried unanimously, the inference being that this union, which was represented at the meeting, had decided to join the federation, and many of our members, seeing this misleading statement, have assumed that this is the case. I trust that this disclaimer will reassure them and other such persons who are interested in the union.

A. G. CHURCH, Secretary.

National Union of Scientific Workers, 10 Tothill Street, Westminster, S.W.1, February 19.

COTTON GROWING IN THE BRITISH EMPIRE.

THE report to the Board of Trade of the Empire Cotton Growing Committee has just been issued (Cmd. 523, price 1s. 6d. net). Briefly, the story there told may be summed up as follows: The British cotton mills have been directly adapted to utilise the American long-staple cottons, and they produce, in consequence, the high-class goods for which they are famed. The mills may, in fact, be described as unable to use up the abundant, though much shorter, staples of India and certain other countries of the British Empire. For some years past the mills of the States have begun to work up more and still more of their home supply (of superior cottons), so that the position has thus come about that Britain must be prepared, in the near future, to dispense with a large amount of the American raw cottons hitherto regarded as essential. In what way and how soon can this feat be accomplished? Delay may mean famine to the immense community (something like 5,000,000 people) more or less dependent on the cotton mills of Lancashire.

The answer is presumed to have been given by the report before us. But the perusal of the volume leaves a somewhat confused impression, in which we seem to have been studying something closely resembling the meanderings of a great river which flows through the tropical and sub-tropical regions of the world. It engulfs many great tributaries, and is finally discharged into the ocean of British cotton manufacturing interests by six mouths or sub-committees. All this may be fine, and certainly is ingeniously elaborated, but when we read that it is intended to flow on for ever, we begin to wonder if a complex organisation of impersonal and mutable committees is likely to prove the most satisfactory course for obtaining the very-much-to-be-desired results.

The raising of funds (Imperial and Colonial, etc.); the organisation of existing resources; the institution of greater specialisation in the working up of available supplies; the establishment of improvements in handling, transporting, and marketing the raw staple; the prevention of the practices of adulteration and damping; and many other such subjects, are all dealt with in the report, but they do not seem to resolve themselves into the promulgation of a concrete scheme of increased and improved production. Nevertheless, we are assured that the British Empire can be made self-supporting in this matter, though we are not told where or how this is to be accomplished. It must be confessed that the whole history of cotton improvement is most disheartening. We read, for example, of a great scheme having been floated, some seventy years ago, to raise in Manchester a sum of 20,000,000*l.* to be expended in India, during five years, in measures calculated to forward India as a cotton-producing country. Nothing came of that great conception, though spasmodically, after intervals of neglect (due to increased American supply), Associations, Committees, and Commissions were formed, and each in its day aroused considerable interest, but all proved more or less futile. Meanwhile, two great new manufacturing centres gradually progressed into importance—namely, the United States of America and India—and now these have to be reckoned with in the future.

There are, however, in the present report two important schemes—the training of men, and the establishment of research. In both we think the contemplated methods of accomplishment are likely to prove unsatisfactory.

But let the Central Research Institution, proposed in the Committee's report, become a permanent department of expert officials (not a committee of voluntary workers), and have handed over to it a desired programme of work, then we think a definite step would be taken in the right direction. The members of that institute could be held responsible and judged by results. Their programme should be: Research, Education, and Cotton Production. House them, therefore, in a building large enough to have fully equipped laboratories for research, give them as complete a library as possible, and build them a museum and herbarium. But let there be no hair-splitting separations into research as distinct from information—no divided responsibilities. Who can be better qualified to make public the results or materials obtained than the experts concerned? Information cannot, and should not, be separated from research in the way proposed by the report.

One-half at least of all the subjects of research that have to be investigated can be undertaken better in Manchester than in Egypt—the report suggests Egypt. Establish in Manchester a College of Cotton—a Central Research Institution, as it has been called—where both experts and planters can be trained, in close and personal relationship with the great manufacturing interests. One such centre is quite sufficient, and far better than the proposed lectureships and readerships in half-a-dozen colleges or universities, where plant physiology, plant genetics, mycology, entomology, and the like might be taught. In the one, expert and practical men would be directly and immediately trained for cotton planting; in the other, general instructions would be given that might never mature into cotton planting at all. No risks of this kind should be run; general principles of education must never be allowed to take the place of specific training and definite results.

The Indian Committee insist on the need for more detailed botanical investigation of the existing kinds of cotton in most of the cotton-growing tracts. . . . They consider selection as the first step in evolving better types, to be followed by plant-breeding, which, however, should be entrusted to selected officers who can devote personal attention and considerable time to it.

These passages we single out of the report because they denote acceptance of a most important issue. It has far too long been the habit of cotton experts to hold systematic studies up to

ridicule. They have imagined that they were operating on certain species, or they have coined quasi-scientific names for equally illusory forms known to themselves but to no one else. There can be no manner of doubt that not only critical, but also even hypercritical, studies of all the species of Gossypium are imperatively necessary. The work accomplished in one country must be capable of immediate adoption in all others. This involves acceptance of definite specific standards throughout the Empire. No plot of land should, therefore, be cultivated with cotton, in the research experimental farms, without carefully prepared botanical samples being kept of the plant, of its seeds, and of its lint. These should be registered and preserved in both the herbarium and the museum, and, when found necessary, duplicates sent to all research stations, as also to the Central Research Institution. All further experiments could then contrast result after result, until definite progress had been established or the plant rejected as worthless. We require the history of each species to be worked out in the herbarium, and its habitat thereby fully established, before it can be accepted as a unit for investigation.

Then, in collaboration with a fully equipped home institution, there should be opened out branch institutions in each of the more important centres of cotton cultivation within the British Empire. Results worked out in Egypt might be quite unsuited to India, to Africa, or to the West Indies. Each important centre must discover and establish its own stocks. After the students had passed through the home college, they would be sent out to the branch college of the locality for which they were being trained, and made to study there practical cotton planting, as well as learn the local aspects of the industry. They might with advantage be also sent, for a few months, to an American college.

So much for Research and Instruction; but it is next to useless to talk of "investigation" and "education" if no rational scheme can be submitted, side by side, of immediate and direct application. In India, for example, cotton is grown exclusively by natives, each of whom owns but a very few acres. It is believed that the Government is averse to granting land (at present cultivated by the people) to be handed over to Europeans. Tea planting became a European industry because it was organised in uncultivated waste lands. It might, therefore, be recommended to the Government of India to make every effort to organise cotton plantations on such conditions as were found possible. The planter, for example, might be guaranteed against loss while given all profits, but subject after, say, twenty or thirty years to being bought out. If some such scheme could be carried through, it is highly likely that in a very few years cotton planting would be established on a sound commercial basis, and then for a certainty be greedily taken over by the people themselves. Moreover, were it made known in India that a large cotton-growing scheme had been organised by the Government, landed proprietors might be expected to send their sons to England to be trained for running home-farms. Since India is the largest cotton-growing country within the Empire, success there would give the most immediate results; but what may be said of India is doubtless more or less true of most other cotton-growing centres.

It has, however, to be demonstrated that high-class cultivation will pay in order to overcome the peasant cultivation of to-day, with its impecuniosity that precludes advancement. The planters would all be trained pupils of the college, and given the advantages arranged for on condition of carrying out the principles enjoined on them and also of using the stock supplied from the local research station; but their plantations should on no account become experimental farms. The planters should, so far as possible, be free agents. The local research stations would no doubt require experimental farms on which to raise and develop seed, and these should be provided, but every effort should at the same time be put forth to organise a European cotton-planting industry, or at all events an industry on European lines. Indian experience (see the report of the Indian Cotton Committee [1]) would seem to establish at least one great practical conclusion—namely, that there are certain very restricted areas within which the so-called long staples of India can be produced immediately. Assuming that to be correct, cotton planting on a large scale should be at once organised within these tracts as the initial step.

In America success may be described as having been due to three main causes: (*a*) There were no vested interests of native cultivators to contend against; (*b*) the cultivation was undertaken by Europeans who were mostly intelligent farmers; and (*c*) the planters finally rejected the imported stocks, brought from India and the Levant, and evolved purely American stocks. It was these American stocks that gave the world most of the prized fine long staples. The lesson to be learnt is that the three directions indicated should be kept clearly in mind through all future endeavours. We may not be able at once to disregard local vested interests, but we can take the most promising course of ultimately overcoming them—for many years to come, planting must be on European lines if success is to be attained; and finally we must evolve in each centre its own stocks from purely indigenous, or at least long-acclimatised, plants.

Disregard of the vested interests of the people is more dangerous than ignorance of the requirements of the plant. As the Indian Committee says (and very properly), the cultivator's interests are paramount. It is on that account sailing very much too near the wind to speak, as in the report, of "control of seed" and "compulsory measures against cotton pests." No one, of course, could doubt the value of the arguments set forth in these paragraphs, but in certain countries they are highly impracticable. They

[1] Report of the Indian Cotton Committee. (Published by Superintendent of Government of India Printing, 1919.) Price 2s.

could be applied in all Government farms and plantations, but what of the many millions of acres outside? No doubt it would be the most obvious solution of many pests to have a season, like the frost of winter in the United States and in the northern tracts of India, that would kill the cotton plant and the pests as well, so that next year's sowings would stand a chance of being clean. But in many parts of the cotton area of India two cotton crops are taken off the fields every year—the *uppam* and *nadam* of Madras, for example. Cotton may, in fact, be seen growing throughout the year in almost any province of India, one crop coming immediately after the other. The soil is often such that a good staple may be raised on one plot of land, and an inferior on another closely adjacent, and the seasons of their production often overlap. Obviously, while there could not be any compulsory orders that would deprive the individual of his rights, the persuasion of personal advantage, once established by the success of neighbouring large plantations, would in a few years secure all that could be desired.

The salvation of the position is thus the establishment of independent large cotton plantations, but the most serious difficulty is the discovery of the alternative crop or crops most convenient and profitable. It is not cotton growing only (like tea planting) that has to be faced, but systematic tropical agriculture with a full rotation of crops. This aspect of the problem the report has, of course, not dealt with, and has only general principles to offer.

The extension into new areas—more especially lands with rich soils that need only enhanced schemes of water supply to bring them into bearing—is most fascinating, but, as the Indian Committee points out, better results may be looked for from an increase in the average annual yield than from new areas. That view is certainly correct, and should be faced by some practical scheme, and not by a panorama of committees.

GEORGE WATT.

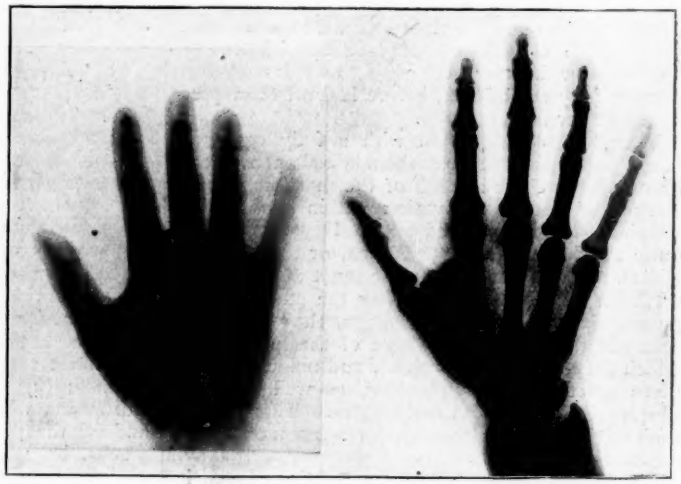
INDUSTRIAL AND MEDICAL RADIOLOGY.

THE extent to which radiology has widened its scope during recent years was strikingly brought out by the exhibition of radiographs held very opportunely by the Röntgen Society at the Royal Photographic Society's galleries during January and February.

Radiology has usually been regarded as a special province of the physician and surgeon, which provides them with a routine means of quick and exact diagnosis. But radiology is spreading its wings into branches of activity far removed from medical endeavour, and the widening of its physical scope cannot fail to react beneficially on the older branch of the subject.

Simultaneously comes the awakening of the medical faculty generally to the importance and promise of physical methods and physical agencies as a means of progress in medical research. There is little doubt that within a short time every large and progressive hospital will have a physicist of standing on its staff; and in this connection we would congratulate the Middlesex Hospital on the good fortune which enables it to establish what we believe is the first medical chair of physics in this country.

In particular, as regards radiology, the physicist will find work to hand in nearly every branch with which he comes in contact. Again, nearly all the problems of equipment and design are physical in character, and need physicists to tackle them, as America has already discovered to her profit. If the physicist can further obtain the co-operation of the electrical engineer, all-round improvements should speedily follow.



(*a*) (*b*)

FIG. 1.—(*a*) Radiograph of hand; exposure 20 mins; January, 1896. (Campbell Swinton.) (*b*) Radiograph of hand; exposure 1/100 sec.; December, 1919. (Knox.)

What of progress to date? The exhibition referred to here, although confined to radiographic prints, could very fairly be regarded as representative of present-day radiography, and as such it received generous approval from both the public and the Press. Some 200 prints were hung representing work by about thirty of the leading workers.

As a radiographer rarely takes his work beyond the negative stage, for the good reason that a print shows him no more, but usually rather less, than the negative, it was gratifying to find so high a pitch of photographic technique in the majority of the exhibits. On the other hand, few exhibitors had devoted much care or thought to the mounting

of their work, a feature which a photographer would never be guilty of neglecting.

About half the exhibition was devoted to medical radiography, and the extraordinary progress that has been made since the discovery of the X-rays twenty-five years ago was strikingly brought out by the juxtaposition of two prints of the human hand (Fig. 1), one taken in January, 1896, by Campbell Swinton, with an exposure of twenty minutes, and the other in December, 1919, by Knox, with a single-impulse flash occupying about 1/100 sec. In the former the bones can be seen, though only blurred; in the latter (with 1/120,000 of the exposure) every detail is brilliantly portrayed. Knox further showed a fine series of flash radiographs of the chest (Fig. 2). Detection of stones in the kidney and bladder is now relatively straightforward work, as the constituent oxalates and phosphates are dense enough to cast good shadows. Until recently gall-stones (consisting chiefly of cholesterin) were deemed impossible of detection, but the radiographer acquires astounding skill in the interpretation of faint shadows, and both Thurstan Holland and Knox showed fine examples of success in diagnosing this troublesome complaint. Fig. 3 is an example of Thurstan Holland's work in barium-meal radiography.

FIG. 2.—Flash radiograph of chest. (Knox.)

FIG. 3.- Right iliac fossa after a barium meal, showing appendix, cæcum ascending colon (with "filling defect" due to malignant growth), an transverse colon. (Thurstan Holland.)

A number of war radiographs were shown; one calling for comment was by Finzi of a bullet in the heart of a man who, it may be added, is still alive. Of interest also was the radiograph of the hand of an Egyptian mummy—a princess of the Second Dynasty (1500 B.C.)—with a scarab ring on the third finger. (Evidently an X-ray equipment will have to be added to the Egyptologist's outfit!)

Some of the most attractive prints were those of shells and rare fossils taken by Rodman; the results reminded one irresistibly of the designs which the harmonograph traces out. Henri Beclere showed a new application of the rays in the radiographing of finger-prints. The skin is first rubbed over with red lead, and the radiograph shows the surface markings and openings of the cutaneous glands in so vivid a fashion as to suggest that the method would have advantages over that normally employed by the Criminal Investigation Department.

Several examples of negative prints on radiobromide paper were exhibited, the most remarkable being that of the skeleton of a man. This radiograph, which was contained on a single sheet, 8 ft. by 4 ft., was taken by Forder with a Coolidge bulb working 8 ft. away.

The use of the X-rays for revealing the interior of plant life is comparatively recent. Considerable differences exist in the mineral content and density, and hence in the transparency, of the different parts of a plant—root, stem, leaf, flower, fruit, seed, etc. It thus happens that even the most delicate structures of plants can be laid bare without tearing the plant to pieces in order to study it. Microscopic detail is, of course, not revealed. Long-waved X-rays are required for such work, of which Knox showed some good flower illustrations.

In the case of timber the different varieties absorb X-rays to different degrees. Peculiarities in the structure and course of the fibres (such as

the contortions which produce "figure") are easily discerned. The denser heart wood is differentiated from the sap wood, the summer and spring growths of the annual rings are readily identified, and defects such as knots or grub-holes show up with astonishing clearness. Kaye and Knox showed some radiographs of aircraft timber and timber-structures taken during the war on behalf

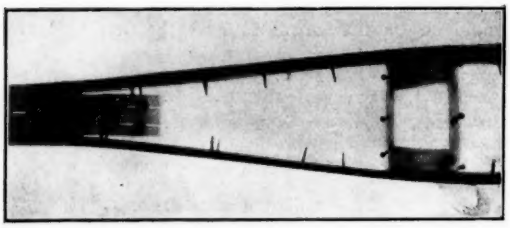


FIG. 4.—Radiograph of aeroplane hollow "box" strut, showing badly fitting internal end-block split by screws. (Kaye and Knox.)

of the Aeronautical Inspection Department (Fig. 4). The method is particularly useful in the case of hollow or laminated components, which cannot otherwise be thoroughly inspected except by destructive tests. Bad gluing, shoddy workmanship, and a variety of timber blemishes are detectable with ease, even on the fluorescent screen.

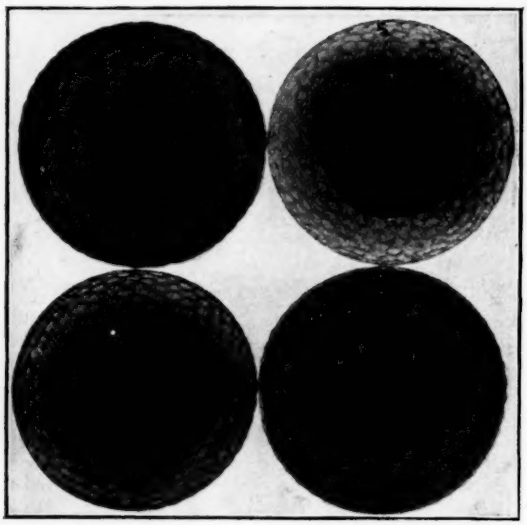


FIG. 5.—Golf balls, showing absence of core in "floaters" and irregular core in others. (Sunic Research Laboratories.)

There appears to be considerable scope for this branch of radiography.

The radiographing of minerals is an easy means of detecting the presence of very dense elements such as uranium or tungsten. Pilon showed a good example of the method. The structure of golf balls is a somewhat unexpected subject (Batten). The "non-floaters" are wound on a core of heavier rubber; some of the cores were spherical, but others were not—to the probable detriment of accuracy in long putting or driving. Undoubtedly the standardised championship balls of the future will have to satisfy an X-ray test!

A neat method of testing the electrically heated clothing of aeroplane pilots was shown by the Sunic Research Laboratories. The heating strip is sewn within the lining of the leather garment, and any break or kink in the element can easily be "spotted" on the fluorescent screen. The same laboratories showed radiographs of outer covers of motor and aeroplane tyres, and a variety of welds in metal tubes and plates, one of these of a steel plate $\frac{1}{2}$ in. thick being of particular excellence (Fig. 6). The Cox-Cavendish Co. showed a somewhat similar collection, and Chambers and Rankine displayed examples of their curious "diffraction" and multiple image X-ray photography.

Among the most novel exhibits were those by Heilbron illustrating the X-ray examination of old paintings with the object of detecting alterations or additions made since the original work. Success in discovering any such falsifications would be

FIG. 6.—Bad weld in steel plates $\frac{1}{2}$ in. thick. (Sunic Research Laboratories.)

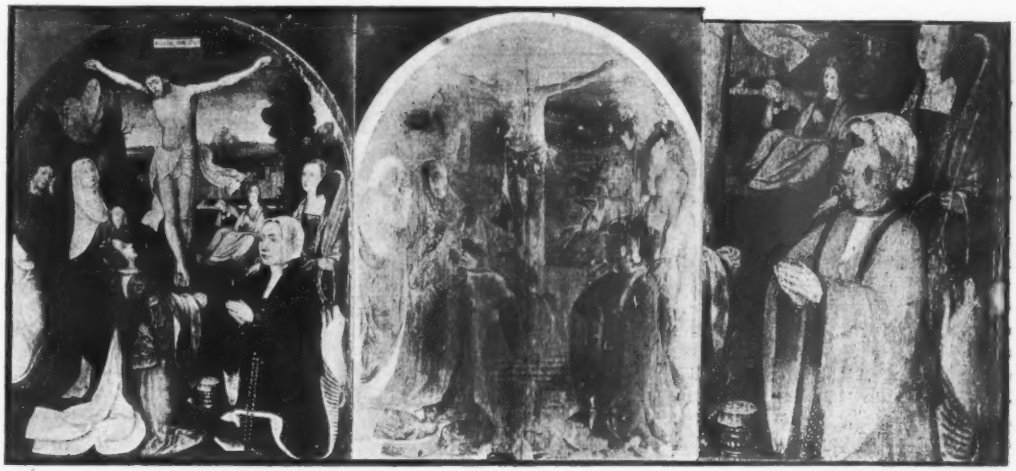
possible only if the paint used in the original work were denser than that used in the additions. Some of the ancient pigments used by the masters are obscure in composition, but the blacks, for example, of a more modern day are largely carbon, and very transparent. Two examples of the method were shown, both by Dutch masters of the early sixteenth century. In one, a panel of the Madonna by St. Jans, the X-rays showed that the arms (which appear in a stiff and unnatural attitude) formerly held the Child, and in the other, the "Crucifixion" by Engelbrechtsz (Fig. 7), the radiograph revealed a number of "restorations," including the painting of the portrait of a former "donatrice" over the picture of a monk. As the *Times* remarked in a recent leader, this method of detecting the presence of later additions imposed on the work of the original artists suggests a great field for the re-investigation of palimpsests and ancient manuscripts hitherto regarded as carrying only their face value. Under the trivial inscriptions of medieval monks there may be revealed older matter of priceless worth. We commend the notion to the directors of the various art galleries and museums.

Space considerations have compelled a some-

what invidious selection of exhibits for comment, and we have had to leave much interesting and clever work unnoticed. But, granting the scope and versatility of the attack, we venture to predict that the exhibition will be as nothing to a similar one held, say, in five or ten years' time. Great improvements are imperative, and will doubtless be forthcoming, in the means of registering X-rays. Photographic plates and fluorescent screens need to be improved out of recognition. A good explorer for use in radio-metallography could doubtless be evolved by means of the thermionic valve, as in wireless telegraphy.

With improved equipment radiology will acquire powers which will give it acknowledged status among the sciences, and medical radiology will find an unquestioned place in every medical curriculum. The diploma of medical radiology established last term by the University of Cambridge is a first step. An even bigger one would be the setting up of an X-ray institute in London, which, properly staffed and equipped, would lead to incalculable progress. We understand that such an institute forms part of a forthcoming memorial scheme to the late Sir James Mackenzie Davidson, which we trust will command generous support.

G. W. C. KAYE.



(*a*) (*b*) (*c*)

FIG. 7.—The "Crucifixion" by Cornelis Engelbrechtsz (*c.* 1500). (*a*) Natural photograph. (*b*) Radiograph showing monk in surplice and stole underlying portrait of "donatrice" on right (Heilbron). (*c*) Natural photograph taken during process of restoration, revealing monk.

REAR-ADMIRAL R. E. PEARY, U.S.N.

THE death of Rear-Admiral Peary at Washington on February 19, at the age of sixty-four, removes one of the most remarkable of modern explorers. It is not so much to the crowning achievement of his life in reaching the North Pole that Peary's claim to the respect of the geographical world is due as to the manner in which he persevered, in the face of almost overpowering difficulties, with very slender resources in a cumulative effort to succeed. The really remarkable thing about Peary is that the method by which he achieved success was practically independent of modern developments in the art of travel. Before very long the North Pole will be accessible by aircraft; it is possible that it might have been attainable years ago by a steamer in an exceptionally open season, but Peary reached the Pole without mechanical help, by the exercise of the powers of human mind and body alone; and had he been a contemporary of Hudson or of Davis there seems to be no reason why his genius could not have won success in the sixteenth or seventeenth century as well as in the twentieth.

Peary's professional training was that of a land-surveyor and civil engineer, and from early youth he was accustomed to find his way through unmapped solitudes and to survey routes hitherto untrodden. He was engaged, amongst other things, on the survey of the abortive Nicaragua Canal after he had joined the civil engineering branch of the United States Navy, and his naval rank must not be taken to imply that he was in any sense a sailor. His official work lay in the construction of harbours and dockyards, and the world owes a debt to the enlightened chiefs of the United States Navy, who recognised that they were making a wise use of their powers in granting this born explorer unlimited leave for Arctic work.

Peary was led to visit Greenland for the first time in 1886 on account of his interest in Baron Nordenskiöld's journey on the inland ice, and he returned from the trip determined to continue the exploration of the ice-cap in its least-known parts. In 1891–92 he spent thirteen months in northern Greenland, establishing himself amongst the Etah Eskimo on Whale Sound, and making a 1200-mile journey with dog-sledges to the north-eastern

extremity of Greenland. In 1893–95 he spent twenty-five months in travelling from the same headquarters and proved the insularity of Greenland. The result of his three years' life with the Eskimo was not only to make a thorough anthropological study of the tribe, but also to secure the personal friendship of every member of it, and to become intimately acquainted with the character of every individual, so that, in selecting travelling companions from amongst them, he knew in advance what their powers were and how far they could be trusted. He found that it was possible to live with the Eskimo as one of themselves, and so to make himself independent of the luxuries, and even of many of the supposed necessities, of civilised life without diminishing his power of travelling or of scientific study.

In 1896 and 1897 Peary made summer trips to the north-west coast of Greenland, and brought back from Cape York the famous mass of meteoric iron weighing 90 tons the existence of which had been reported by Sir John Ross nearly a century earlier. The description of the shipping of this mass of metal on a small vessel with no appliances save those which could be improvised on the spot showed how Peary, in becoming an explorer, had not ceased to be a very able civil engineer.

By this time Peary's plan for reaching the North Pole had been fully matured. He resolved to transport a picked contingent of the best of the young men of the Eskimo tribe he knew so well to the farthest north point accessible by sea, and to leave them there with their wives, families, and full equipment in an absolutely normal settlement where they would be happy and contented. From this base he was to travel north as far as the land extended by easy stages, and make a second settlement of the best natives at that point. Thence he proposed to make a continuous march over the sea ice to the Pole and back, waiting for a favourable opportunity, and spending the waiting time, whether it should be weeks or years, in studying the effects of wind and tides on the ice-movements. Lord Northcliffe presented to him the steamer *Windward*, which had done good service in the Jackson-Harmsworth expedition to Franz Josef Land, and, under the auspices of the Peary Arctic Club of Philadelphia, Peary set out on his great task in 1898. It was 1902 before he returned, having reached only 84° 17′, but, in spite of the severest hardships, he was more convinced than ever of the soundness of his method of exploration. In 1904, while recovering from his privations, Peary presided over the Eighth International Geographical Congress in Washington and New York, impressing all who attended that brilliant meeting with the confident, yet modest, assurance of his ultimate success by the methods he had worked out.

In 1905 Peary started in the new exploring ship *Roosevelt*, but had to return in 1906 with no greater success than the attainment of latitude 87° 6′, the farthest north that had been reached so far. Finally, in 1908, he went north for the seventh time, again in the *Roosevelt*, and at last, by the perfected working of his original plan, he hit the fortunate trend of ice and weather and reached the North Pole on April 6, 1909. It will be remembered how the pleasure of this triumph was marred by the pretension of Dr. F. A. Cook to have attained the Pole a year earlier; but the unfortunate controversy held at least this crumb of comfort, that Cook's claim, unfounded as it was, was to have attained success by Peary's method of travelling with trusted Eskimo.

Peary had a fine presence and a forceful diction in speech and writing, his books are amongst the most stimulating for the reading of young explorers, and his careful inductions and thoroughly reasoned plans are a model to all who have to do with the promotion of exploration. He was supported in all his efforts by his wife, who accompanied him on two of his expeditions.

H. R. M.

ROBERT ETHERIDGE.

MR. ROBERT ETHERIDGE, director of the Australian Museum, Sydney, died on January 4 last at the age of seventy-three years. He was active almost until the end, still occupied with research, and his decease is a serious loss to Australasian science. The only son of the late Mr. Robert Etheridge, palæontologist to the Geological Survey of Great Britain, and afterwards assistant-keeper of the geological department of the British Museum, Etheridge adopted the profession of his father, and made many important contributions to our knowledge of the fossils of both Australasia and Britain. Beginning his career on the first geological survey of Victoria, Australia, he returned in the early 'seventies to become palæontologist to the Geological Survey of Scotland, where he not only did important official work, but also co-operated with the late Prof. H. A. Nicholson in describing the Silurian fossils of Girvan, Ayrshire. From 1878 until 1887 he was assistant in the geological department of the British Museum, where he joined the late P. Herbert Carpenter in the authorship of the "Catalogue of the Blastoidea," which still remains the standard work on these fossils.

Colonial life, however, had special attractions for Etheridge, and in 1887 he returned finally to Australia as palæontologist to the Geological Survey of New South Wales and to the Australian Museum. He started two new serials, the Records of the Geological Survey and the Records of the Australian Museum, and published many memoirs and papers on Australian fossils. He also joined R. Logan Jack in preparing two handsome volumes on "The Geology and Palæontology of Queensland and New Guinea," which were published in 1892. In 1895 he succeeded E. P. Ramsay as director of the Australian Museum, but his new administrative duties did not damp his ardour for research,

merely extending its scope. He added a deep interest in the aborigines to his earlier pursuits, and wrote, among other works, valuable memoirs on the dingo and on the sculpturing of sacred trees.

Etheridge was always absorbed in his science, and shunned ordinary social life, so that his real good nature could be appreciated only by a very small circle of intimate friends. His scientific worth, however, was widely acknowledged, and he received the Wollaston Fund from the Geological Society of London in 1877, the Clarke medal from the Royal Society of New South Wales in 1895, and the Mueller medal from the Australasian Association in 1911. His name is also associated with the Etheridge goldfield in North Queensland, a high peak on the Kosciusko tableland, and a glacier in Antarctica.

A. S. W.

NOTES.

THE report of observations of a gigantic dinosaurian reptile in the Congo region of Africa, which was made the subject of sensational articles in December last, proves, as we surmised (NATURE, December 18, p. 396), to be without foundation. Mr. Wentworth D. Gray, Acting Representative of the Smithsonian African Expedition in the Katanga, writing from Elisabethville on January 21 to the *Times* of February 23, says:—"I am authorised to contradict the statement that the members of the Smithsonian African Expedition who proceeded to this territory came here to hunt the Brontosaurus. There is no foundation for this statement. I may also state that the report of the Brontosaurus arose from a piece of practical joking in the first instance, and, as regards the prospector 'Gapelle,' this gentleman does not exist except in the imagination of a second practical joker, who ingeniously coined the name from that of Mr. L. Le Page."

THE first meeting since 1914 of the International Council for the Exploration of the Sea will be held in London on March 2. Delegates will be present from Belgium, Denmark, France, Finland, Holland, Norway, and Sweden. Russia and Germany are not represented, and France sends delegates for the first time. The German investigations, it is now known, have been resumed, and the steamer *Poseidon* has been working at sea since last September. The council, it is expected, will consider arrangements for the resumption of the pre-war investigations, and will devote special attention to tracing the effects of the restrictions on fishing during the war period on the abundance of fish in the North Sea. Proposals for the closing of certain North Sea areas against steam-trawling are, it is understood, to be considered. Arrangements are being made by the British Fishery Departments for an early beginning of an extended programme of research. The question of the inclusion of Germany has not yet been considered, but it is believed that there is a growing feeling in this country that she should be invited to participate.

THE Home Secretary, Mr. Shortt, announced in the House of Commons on February 24 that it is proposed that summer time shall begin on March 28 and end on September 27.

WE regret to announce the death, at seventy-five years of age, of Prof. J. Emerson Reynolds, F.R.S., professor of chemistry and chemical philosophy in Dublin University from 1875 to 1903.

MR. J. S. DUNKERLEY, of the University of Glasgow, and Mrs. E. W. Sexton, of Plymouth, have been appointed Ray Lankester investigators at the Marine Biological Laboratory, Plymouth.

THE lecture entitled "Some War-time Efforts in Chemical Industry at Gretna," arranged to be given by Mr. J. C. Burnham before the fellows of the Chemical Society on March 4, has been unavoidably postponed. The usual ordinary scientific meeting for the reading and discussion of papers will be held on that day.

AT the meeting of the Chemical Society held on Thursday, February 19, it was stated that the following changes in officers and council had been proposed by the council:—As secretary, Dr. H. R. Le Sueur *vice* Prof. S. Smiles. As vice-presidents, Prof. J. B. Cohen and Prof. S. Smiles *vice* Prof. A. Smithells and Prof. S. Young. As new ordinary members of council, Prof. A. J. Allmand, Dr. E. F. Armstrong, Mr. F. H. Carr, and Dr. J. T. Hewitt.

A DEPARTMENTAL Committee has been appointed by Dr. Addison to consider the present state of the law with regard to the pollution of the air by smoke and other noxious vapours, and to advise what steps are desirable and practicable to diminish the evils still arising from such pollution. The members of the Committee are:—Lord Newton (chairman), Capt. Hamilton Benn, Prof. J. B. Cohen, Mr. S. Curphey, Sir John Lithiby, Mr. J. F. MacCabe, Mrs. Gilbert Samuel, Mr. E. D. Simon, Bailie W. B. Smith, and Mr. F. J. Willis. Mr. E. C. H. Salmon, of the Ministry of Health, will be secretary, and any communication should be addressed to him at the Ministry, Whitehall, S.W.1.

THE officers and council of the Physical Society elected at the annual meeting on February 13 are as follows:—*President:* Prof. W. H. Bragg. *Vice-Presidents:* Dr. H. S. Allen, Prof. W. Eccles, Prof. A. S. Eddington, and Dr. R. S. Willows. *Secretaries:* Dr. D. Owen (Birkbeck College, Bream's Buildings, London, E.C.4) and Mr. F. E. Smith (National Physical Laboratory, Teddington). *Foreign Secretary:* Sir Arthur Schuster. *Treasurer:* Mr. W. R. Cooper (82 Victoria Street, S.W.1). *Librarian:* Dr. A. O. Rankine (Imperial College of Science and Technology). *Other Members of Council:* Mr. C. R. Darling, Prof. C. L. Fortescue, Dr. E. Griffiths, Dr. E. H. Rayner, Dr. A. Russell, Sir Ernest Rutherford, Dr. G. F. C. Searle, Mr. T. Smith, Dr. J. H. Vincent, and Mr. F. J. W. Whipple.

THE *Morning Post* of February 17 contained an article from its correspondent in Paris stating that three days previously he had witnessed five experiments at a works in the northern suburbs of the city, each of which involved the production of a ton and a half of "high-class steel." At the present time such steel is made either in crucibles or in an electric or an open-hearth furnace. The novelty of the experiments referred to consists in the fact that the steels are made in some form of "converter" of the Bessemer type. Usually this process does not give a sufficiently scientific control of the product to enable high-class steels to be made. It appears from the account given that certain "secret substances" are added which have the effect of controlling the quality of the metal produced, so that it can be used as a basis for the manufacture of high-grade alloy steels. The process is said to have been worked out by four inventors, two of whom are Belgians. The demonstration was witnessed by about a dozen metallurgical experts, who were engaged in taking samples for tests. If the claims of the inventors are substantiated the process will be one of considerable practical importance, and further details will be awaited with interest. It is stated that they have decided not to patent their method, but to operate it as a secret process.

NEWS has just been received of the death at Cairo of Mr. Henry Gribble Turner at the age of seventy-seven years. Mr. Turner joined the Madras Civil Service in 1864, and soon gained a reputation by his successful management of the wild tribes of Vizagapatam district on the east coat, a region where the practice of human sacrifice in honour of the Earth goddess had recently been discontinued. After holding for a time the office of Postmaster-General, he returned to his old district, Vizagapatam, which he administered with much credit until his retirement in 1889. It was due to Mr. Turner that, in the face of great opposition, the standard-gauge railway linking Calcutta with Madras was constructed. He was a skilled mineralogist, and discovered the Vizagapatam manganese deposits, the trade in which has so rapidly developed that the total export is now 600,000 tons annually. He also started the export of Indian magnesite, which proved most useful during the war. Another of Mr. Turner's projects was a harbour at Vizagapatam to serve the rich uplands of the interior, a scheme which is now at last to be undertaken. He failed to secure election as Member for South Somerset in 1895, and he thus escaped the fate of more than one distinguished Indian administrator who did not succeed in making his mark in the House of Commons.

THE committee of the Sheffield Museums and Mappin Art Gallery has issued a consolidated report for the last five years. Special attention is directed to an exhibition relating to infant welfare which was held in 1916. The exhibits were of a comprehensive character, and a series of descriptions was prepared by Dr. Scurfield, Medical Officer, and Dr. Lucy Naish, which is now republished. The instructions in all questions relating to the care of children are elaborate and arranged with full knowledge and much common sense. The authorities of other provincial museums might consider the advisability of reprinting the pamphlet, which is likely to be of much utility.

IN the February issue of *Man* Mr. A. C. Breton describes a remarkable picture-map from Mexico in the manuscript department of the British Museum. The museum authorities acquired the map from Mr. H. Stevens, who, in his turn, purchased it from the original finder, Col. Campos. It was found on the site of the ancient Indian city of Metlaltoynca, in a stone chest which appears to have formed the pedestal of an idol. Several remarkable statues have been found on this site, and the building depicted in the centre of the map is somewhat like the existing Castillo, a pyramid on a base with six high steps and a platform, on the summit of which are buildings. The interpretation of the figure-groups in the map is still to some degree uncertain, but its publication will doubtless lead to an elucidation of its meaning.

THE identification of two statues in the Indian Museum, Calcutta, found at Patna about a century ago, has aroused much interest among Indian archæologists. The question of the date of these statues and of the inscriptions engraved upon them is discussed in vol. v., part 4, of the Journal of the Bihar and Orissa Research Society. Dr. Vincent Smith, in one of the last articles that came from his pen, was disposed to believe that they are portraits of two kings who reigned in the fifth century B.C. This conclusion, if it be correct, revolutionises the current view of the development of Indian art, because hitherto it has been supposed that stone sculpture began in the time of Asoka, who reigned some two centuries later than the assumed date of the Patna statues. Moreover, the execution of these presupposes a long prior development of plastic art. But it must be remembered that the dates of the statues are not yet quite certain, and the question is still under discussion by archæologists.

IN *Sudan Notes and Records* (vol. ii., No. 4, October, 1919) Prof. G. A. Reisner announces the discovery for the first time in the Nile Valley of a horse cemetery. The graves were in four rows, and four complete skeletons were discovered, the horses being of a short, small breed, not unlike the Arab. Each horse was buried with its chariot trappings—they were not ridden at that period—and placed upright with the head towards the south. The regular spacing of the graves, the division into rows, the chronological order of the rows, and the uniformity of the graves in each row justify the conclusion that these horses were sacrificed at the funerals of the kings in order that the spirits of the horses might accompany the spirits of the kings into the other world. The idea is widespread, but in this special form it was hitherto unknown in Egypt. But excavations recently made at Kerma show that the sacrifice of men and animals at funerals was a well-established ancient Ethiopian custom. In fact, there seems reason to believe that horse-sacrifice was due to King Piankhy, who was a great connoisseur of horses, as is proved from his inscriptions.

PROF. C. E. A. WINSLOW, in an address to the American Association for the Advancement of Science entitled "The Untilled Fields of Public Health," expressed the opinion that the public health campaign of the future would need the collaboration of at least the seven following types of highly qualified experts: the physician, the nurse, the bacteriologist, the epidemiologist, the engineer, the statistician, and the social worker. In addition, there must be inspectors to supervise sanitary and housing conditions, and, finally, the administrator who organises and develops the work of all the rest. The latter ought to be medically trained, with subsequent specialisation in public health (*Science*, January 9, p. 23).

THE February number (vol. i., No. 5) of *Medical Science: Abstracts and Reviews*, published for the Medical Research Committee, has reached us. Reviews of current work on medical subjects appear monthly, diseases of the respiratory system and cardio-vascular diseases, among others, being dealt with in this issue. In the article on the former, reference is made to the question of the production of emphysema of the lungs (a condition of permanent distension with other changes) by the playing of wind-instruments, as is stated in many text-books. Of forty-six professional players examined, in only three was there slight evidence of emphysema, so that the commonly accepted view seems to be without foundation.

WE have received the quarterly report of the Research Defence Society, dated January, 1920, when the society completed its twelfth year of active work. The society was founded to make known the value and the necessity of experiments on animals, the restrictions imposed on them in this country under the Act of 1876, the nature and the purposes of the experiments which are being made, and the discoveries which have come by the help of the experimental method; also to bring about a better understanding between the few who make these experiments and the many who profit by them. The campaign has been carried out by the circulation of pamphlets, by articles in the Press, and by public lectures. The president of the society is Lord Lamington, and the hon. secretary Mr. Stephen Paget.

MAJOR-GEN. SIR W. LEISHMAN publishes in the *Lancet* of February 14 (p. 366) the results of protective inoculation against influenza in the Army at home during 1918–19. The vaccine consisted of a mixture of three micro-organisms, the influenza bacillus, streptococci, and pneumococci. Among the inoculated, numbering 15,624, the incidence per thousand was:—Of attack, 14·1; of pulmonary complications, 1·6; and of deaths, 0·12. Among the uninoculated, numbering 45,520, the figures were 47·3, 15·3, and 2·5 respectively. At least half of the vaccinated received one dose only, and not two doses as recommended, and the vaccine used at first was considerably "weaker" than that used later. Nevertheless, the figures are decidedly favourable to the value of vaccination, particularly as a preventive of mortality from influenza.

MR. E. E. LOWE, in the *Museums Journal* (vol. xix., No. 7), utters a timely word of warning to the curators and governing bodies of local museums in regard to the haste they are displaying to be taken over by the Board of Education, as recommended by the Adult Education Committee of the Ministry of Reconstruction. If this fate ever overtakes them they will have ample time for unavailing repentance. Mr. Lowe's arguments are stated with considerable ability and force, and his views on the functions of museums are eminently sound. The modern museum, he urges, should, among other things, be educational, but he points out that it would constitute a grave error of judgment, as well as a breach of trust, to hand over museums to the local education authorities.

FROM *California Fish and Game* (vol. vi., No. 1) we learn that extensive plant is being set up at Tropico, California, for the preparation of agar-agar on a commercial scale. Experiments have been carried out which seem to show that agar-agar of a quality much superior to the imported article can be produced from the seaweeds native to the coast of southern California. If this venture is successful, it will create a new industry for the United States. In the same issue a series of figures illustrating the growth of the young of the black sea-bass or jew-fish (*Stereolepis gigas*) is given. These furnish a very striking illustration of the "recapitulation" theory, and explain how it is that the fishermen were unaware of the connection between the gaily coloured fish of a few inches long, with enormous dorsal and ventral fins, and the unicoloured giant in which these fins are relatively extremely small.

THE very handsome volumes issued in 1916–18 by the Maryland Geological Survey have now become available in Europe. They are largely a memorial to the energy of the director, William Bullock Clark, who held office for twenty-five years, dying at too early an age in 1917, and whose obituary, with a portrait, appears in vol. x., which includes his latest educational work, "The Geography of Maryland." This is now published as an amplification of the treatise already used in the State schools. Part 2 of this volume deals with water-supply, and the somewhat massive style of publication—a heritage from the traditions of the United States Geological Survey—makes one wish that the geographical part could have been issued separately bound. Mr. Clark and his staff also contribute two fully illustrated volumes on "The Upper Cretaceous Deposits of Maryland." These occur mainly on the left bank of the Chesapeake Inlet, opposite Baltimore, and are specially noted for their dicotyledonous flora. The Maryland Geological Survey, in continuation of its series of county descriptions, which recall the ambitious scheme of the Ordnance Survey of Ireland in 1837, published in 1917 its memoir on Anne Arundel County; this is written by a number of specialists, so as to present the area south of Baltimore from a geographic point of view. The co-operation of the United States Geological Survey enables this finely illustrated work to be accompanied by four large folding maps on the scale of 1/62,500 (four times that of the 1/250,000 sheets), showing the topography and political divisions, the geology, the soils, and the forestry and commercial areas.

THE scientific portion of the *Central Zeitung für Optik und Meckanik* for January 1 contains the first of a series of articles by Prof. von Rohr on the principal points of optical systems and the graphical methods of determining images. The constructions given are those suitable for convex and concave systems of which the principal planes and foci are given. The industrial portion includes a reproduction of the new regulations under which optical workers of eight years' standing may attend shortened courses of instruction at the Government optical school at Jena and, after a qualifying examination, obtain the optician's diploma. A list of the optical and other instruments for which there is at present a demand in foreign countries is given. The wages paid to the various grades of workers in metal in the principal countries of the world form the subject of a further article. A list of the publications of the German Committee on Standards for Industry is provided, and the importance of the rapid adoption of the new standards throughout the country is emphasised. Coloured wall-charts have been prepared, so that the information may readily be placed before the eyes of designers, foremen, and workmen.

IN a paper in the *Chemical Age* of February 14 Dr. Stephen Miall plots the atomic weights of the elements against their atomic numbers, and shows that all the elements lie upon a series of parallel lines of three different slopes. The atomic weights may be represented as $bx+a$, where x is the atomic number, a a small integer ranging from 0 to 5, and b has the value 2 for the elements from helium to nickel, 2·5 from copper to tungsten, and 3 from osmium to uranium. The first term, which contributes to the chemical character, he terms "live-weight," and the second term, which is of no influence on the chemical character, "dead-weight." Similar regularities have been previously pointed out, and, indeed, since the atomic weights for the most part conform to integral values, some such relation as the above is necessarily true. But the diagrams have a value apart from their interpretation. They suggest a novel basis for classification, and arrange the elements on parallel lines for which a and b have the same values. They may be useful to those seeking for regularities in the nuclear structure rather than in the atomic shell. Hitherto chemists have been too exclusively obsessed with the study of chemical character to the neglect of the atomic weight—an independent variable, as the study of radio-active change has made quite clear. The atomic weights, however, as the author remarks, mean something. They furnish the only present clue to the structure of the nucleus.

THE Carnegie Institution of Washington has issued another section of its monumental "Index of Economic Material in Documents of the States of the United States." The section, prepared by Adelaide R. Hasse, is the first instalment of the index relating to the State of Pennsylvania. Part i. contains the titles of collected documents, mainly printed by authority of the Senate and of the House of Representatives. Part ii. is a topical analysis arranged alphabetically from A to E. Among the longer sections we find Agriculture, Canals, Climate, Coals, Coal-mining, and Education. The period covered is from 1790 to 1904. The new volume has been preceded by twelve similar quarto volumes, and will be followed by others, each devoted to a single State. The index undertakes to deal only with the printed reports of administrative officers, legislative committees, and special commissions of the States, and also with Governors' messages. References are given by volume and page to all material of economic importance contained in the reports and messages indexed. Under each sub-heading the arrangement is chronological. In the alphabetical part the compiler has introduced, in addition to subject entries, the names of persons who have exercised an important influence on the development of the economic life of the State. After each name there is reference to work done. The amount of material which had to be examined for the preparation of this volume must have been very great.

A SHORT but useful list of books on ornithology and oology (No. 398) has just been circulated by Mr. F. Edwards, 83 High Street, Marylebone, W.1. It contains some two hundred and fifty items, including several long runs of serials such as the *Ibis*, Transactions and Journals of the Royal Microscopical Society of London, Proceedings of the Zoological Society of London, etc. The list is sent free on application.

OUR ASTRONOMICAL COLUMN.

HOLMES'S COMET.—Dr. Schorr reports that the cometary object 1919*f*, found on two plates taken at Bergedorf by Dr. Baade on December 10, is definitely not identical with Holmes's comet, as it failed to appear on two plates taken on December 26, on which it would have been registered if it were moving in accord with the ephemeris calculated for that comet.

MINOR PLANET GM.—This is the object discovered by Señor Comas Sola on January 13, and considered for a time to be a comet. As it is the brightest minor planet discovered in recent years, it is of interest to give the elements which have been deduced at the Berkeley Observatory, California.

$T = 1920$ March 16·36 G.M.T.
$\omega = 194^\circ\ 28'$
$\Omega = 300^\circ\ 0'$ } 1920·0
$i = 17^\circ\ 59'$
$q = 2{\cdot}326$
$e = 0{\cdot}1109$
Period = 4·2315 years

Ephemeris for Greenwich Midnight.

	R.A.	N. Decl.	Mag.
	h. m. s.	° ′	
February 28 ...	7 25 26	17 33	11
March 7 ...	7 24 54	16 44	

NOVA IN LYRA.—Harvard Bulletin No. 705 reports the finding of another nova on the Harvard photographs by Miss Mackie. Position for 1900·0, R.A. 18h. 49m. 30s., N. decl. 29° 6·3′. Between December 4 and 6 it rose suddenly from mag. 16 or fainter to mag 6·5; on January 6 it had sunk to 8·5. Messrs. Adams and Joy report from Mount Wilson that its spectrum shows the striking nova characteristics.

The same message reports that these observers find remarkable changes in the spectrum of Mira Ceti, the bright helium and hydrogen lines being strengthened and widened towards the red.

TIDES IN PIPES.—In 1914 Messrs. A. A. Michelson and H. G. Gale made a preliminary investigation of the tidal changes in water-level in two pipes, each 502 ft. long, placed respectively along a meridian and a parallel, in the grounds of the Yerkes Observatory. They have now made a more refined series of observations (described in the *Astrophysical Journal* for December). The small changes of water-level are registered by photographing interference fringes produced by placing a mirror about ½ mm. below the surface of the water, and passing a beam of light from an electric lamp vertically down through the water-film, then reflecting it on emergence into a camera in which a sensitive film is moved by clockwork at the rate of 2 cm./hour. Some of the photographed curves are reproduced, and show a beautiful accord with the theoretical curves, which were carefully calculated by Prof. F. R. Moulton. The transition from spring to neap tides, and even the difference in height of alternate semi-diurnal tides, are obvious at a glance. The result shows that the pipe tides are 0·690 of what they would be on a rigid earth, so that the bodily tides in the earth's crust are 0·310 of what they would be if the earth were fluid. The earth tides appear to lag behind the impressed forces by 4°. This method avoids many of the complications that are present in the observation of ocean tides; it also appears to be capable of greater relative precision, in spite of the smallness of the quantities involved.

There appears to be a slip in the value of the rotational velocity ω (p. 350); it is printed as 2π sidl. day/solar day, but surely it should be 2π solar day/sidl. day, the mean solar day being the unit of time employed.

LUMINOSITY IN CENTIPEDES.[1]

AS Chilopoda have been traced back to the Carboniferous age by the palæontologists, these centipedes may be presumed to have understood their own interests pretty well in the struggle for existence. *Geophilus electricus* (Linn.) had already won the attention of Aldrovandi in the sixteenth century, and the specific name adopted for it by Linnæus was obviously based on its observed luminosity. The notes now under review state that among the centipedes only one great group, the Geophilimorpha, is known to exhibit the phenomenon.

With so long a history for the group in the modern period, it seems strange that biologists should still need to ask in regard to some of its species, which are by no means uncommon: Why are they luminous? Even those keen observers, Mr. and Mrs. Brade-Birks, after minute examination, with the aid of friends, and critical comparison of recent authorities, leave the subject inconclusively concluded. Microscopists will read with pleasure details of the contrivances by which they persuaded their many-legged, wriggling subjects, under just the friendliest squeeze, to sit for their portraits. As definite result of their careful study of *Geophilus carpophagus*, they "conclude that in the excretion which accompanies luminosity there are generally present: (i) the contents of the white glands, for [which they] propose the name of *protoluciferin*, (ii) mucin, (iii) acid." The expression "white glands" seems to be used rather vaguely, as applying to certain white, rounded masses on the ventral parts of the specimen, these masses being "groups of pyriform, and probably unicellular, glands intimately associated with the production of light." But it is not made clear whether whiteness is a property of individual glands or only an effect of their grouping into opaque masses.

For an understanding of the debate on the value of lighting up as displayed in this very limited section of the animal world, Dr. Shipley's brief notice may usefully be quoted. He says:—"Some members of the family Geophilidæ are phosphorescent, and secrete from certain glands on the ventral surface a luminous slime; since this is produced by both male and female, and neither of them has eyes, the secretion is regarded as a means of frightening or warding off enemies. The male Geophilus spins a web, and drops a spermatophore in the middle of it, and the female comes and fertilises herself" ("Zoology of the Invertebrata," p. 315). The present collaborators suggest that, without specialised organs of sight, the Geophilids "may be able to appreciate light by a general absorption of its waves through the surface of the body." Though this inchoate power of vision might be otherwise of service, it could scarcely help in bringing the two sexes together, and the riddle is complicated by the fact that allied species without luminosity seem to arrange their affairs very well in its absence.

In general, experience has shown that animals, other than beasts of prey, are not frightened, but attracted, from a dark environment by illumination, so that among the alternative services of *protoluciferin* suggested by the authors any scaring property may be set aside as very improbable.

The systematist is now warned by our authors that *Stigmatogaster subterraneus* should be attributed to Shaw. So lately as last December, in Nevin Foster's list of fifty-three Irish Myriapods, they sanctioned the long-standing error of assigning the species to Leach. They acknowledge themselves baffled by the specific name of *Geophilus convolvens*, on which Fabre founded his researches. This is said to be not a phosphorescent species. Otherwise one might have supposed the name evolved from the strange account which Lucas cites out of the *C.R. Acad. médicale des sciences de Metz* in 1830. This records the frightful tortures in the head of a young Frenchwoman, which after a year were suddenly terminated "par l'expulsion d'un insecte qui, jeté sur le plancher, s'agitoit avec rapidité et se rouloit en spirale." It, however, was determined to be a specimen of *Geophilus carpophagus*. Leach. Gistel in 1850, writing of the Feuerwurm *Geophilus electricus*, alludes to the story, but does not, in fact, discredit it by remarking that such a species could not penetrate the frontal cavities of a human head unless the owner of the head were asleep. T. R. R. S.

[1] Dartford Naturalists' Field Club Occasional Papers. Notes on Myriapoda. XX. "Luminous Chilopoda, with Special Reference to *Geophilus carpophagus*, Leach." By Hilda K. Brade-Birks and the Rev. S. Graham-Birks.

THE POSITION OF THE METEOROLOGICAL OFFICE.

AT the monthly meeting of the Royal Meteorological Society, held on February 18, Capt. C. J. P. Cave brought forward a paper on "The Status of a Meteorological Office and its Relation to the State and to the Public." It was pointed out that a Meteorological Office is a practical necessity, and, since to be at all efficient it must be subsidised from public funds, it has to be under some Government Department. The work of a Meteorological Office is, however, very wide, and concerns, not one, but almost every Government Department; and if it is to be under one without adequate safeguards, there

is a great danger that many important sides of meteorology will be neglected. Safeguards are that the Director of the Meteorological Office should be directly under the Minister of the Department concerned, and on no account under other permanent officials, and that the Meteorological Office should have its separate vote and account in the Estimates. Hitherto the expenses have been controlled by the Meteorological Committee, a body on which several Government Departments as well as the Royal Society are represented; there seems to be no reason why this arrangement should not be continued. The work of the Meteorological Office concerns not only Government Departments, but also such bodies as county councils, municipal bodies, organisers of engineering undertakings, and the general public; and probably none of these know how great a use may be made of meteorological information.

The public is chiefly concerned with forecasts, and probably the mistrust of forecasts which undoubtedly exists in the public mind is due to the delay that occurs before the forecasts are available. Those that appear in the daily papers are based on observations at 6 p.m. of the previous day, but if forecasts based on the 1 a.m. or 7 a.m. observations were sent to every telegraph office in the country and posted up, and could be obtained by telephone subscribers, it would probably prove a great boon, especially to agriculturists, and do much to dispel the present mistrust of weather forecasts.

During the past year the Meteorological Office forecasts have been issued from the Air Ministry, and in the Air Estimate there appears a sum for the Meteorological Office. From this it appears as though the Office is to pass under the Air Ministry. In former times when any change was made in the status of the Office an official inquiry was held, but no such inquiry has apparently taken place as a prelude to the present change, and no public announcement of any kind has been made. There seems no reason for the change. The Meteorological Office had done work on the upper air long before the war, and it was its work which proved that long-distance night flying was a practical possibility. Meteorology must be a national Service, but the policy of handing it over to one Ministry without a separate vote and account would be disastrous, not only to meteorology as a science, but also to the State at large.

The following resolution was adopted at the meeting:—"The Royal Meteorological Society observes that, in the Air Estimates for 1919-20 published last December there appears a sum of 12,000*l.* as a supplement to the grant in aid of the Meteorological Office. It would appear from this that it is intended that the finances of the Meteorological Office shall pass under the control of the Air Ministry.

"The Meteorological Office deals with a variety of problems of high scientific and practical importance, some of which have no bearings on the work of the Air Ministry, but are closely connected with the work of other Government Departments. While recognising to the full the great benefits to the meteorology of the upper air likely to accrue from a close association with the Service to which a knowledge of the upper air is so essential, and which possesses such facilities for its investigation, this society cannot but feel misgiving that there may be a tendency for other branches of meteorology to receive less than their due attention if one Government Department has the sole control of the finances and management. The society, therefore, is of opinion that the Meteorological Committee should continue to have full control of the expenditure.

"It has been the practice in the past, before any change was made in the body administering the Meteorological Office, for an inquiry to be held by a Departmental Committee. Reports of three such inquiries have been published, the last being that issued in 1904 of a Treasury Committee presided over by Sir Herbert Maxwell, Bart. The Treasury did not adopt the whole of the recommendations of this Committee, but on May 20, 1905, it issued a minute constituting the Meteorological Committee as it has since existed. The society is of the opinion that before the future constitution of the Meteorological Committee and the status of the Meteorological Office are finally settled, it is desirable that an inquiry by a representative committee should be held."

PRE-HISTORY OF MAN IN BRITAIN.

FLINT IMPLEMENTS FROM THE CHALKY BOULDER CLAY OF SUFFOLK.

MR. J. REID MOIR described to the Royal Anthropological Institute on February 17 some interesting flint implements and flakes found in two pits situated to the north of Ipswich, and in a pit at Claydon, to the north-west of that town. In each of these pits Boulder Clay of considerable thickness is exposed, and this deposit, in the opinion of Prof. J. E. Marr, who has visited the sections, is *in situ*, and represents part of the large sheet of Boulder Clay of the Ipswich district. Mr. Reid Moir found many of the specimens described *in situ* in the Boulder Clay, and the others, handed to him by workmen employed in the pits, are of such an order as to make it certain that these implements were also derived from the Boulder Clay. The specimens are in nearly every case made from flakes, and exhibit very little change of surface or signs of abrasion. The two principal types are *râcloirs* and *pointes*; primitive flake-implements and large scrapers are also represented in the series. The technique of these artefacts is in many ways comparable with that of Early Mousterian times, and it is probable that these Boulder Clay specimens are referable to this cultural phase. The implements appear to have been lying in or upon a land surface before being incorporated with the morainic material in which they are now found. One well-made and deeply ochreous flake found in the Boulder Clay appears to be of Chellean age. It exhibits reflaking along its edges, and this flaking is patinated in the peculiar manner of some of the Boulder Clay artefacts.

In the discussion which followed the reading of the paper all the speakers united in dwelling upon the importance of the contribution made by Mr. Reid Moir to the study of the pre-history of man in Britain. Prof. Arthur Keith pointed out that the conclusions which followed from the results of Mr. Reid Moir's investigations could only be described as revolutionary, and would involve a reconsideration of the evidence relating to the antiquity of Stone-age implements. Mr. Reginald Smith said that the *pointe* was considered to be the typical implement of the Mousterian stage of culture. Archæologists would have to consider the possibility of its occurrence in other periods. The peculiar patination which occurred on certain of the specimens found by Mr. Reid Moir in the Ipswich Boulder Clay occurred at Northfleet, and was usually considered to be typical of the Le Moustier period. Mr. Smith also pointed out that some thirty-five years ago Dr. Skertchley had raised the question of the occurrence of palæolithic implements below the Boulder Clay. Dr. Barnes remarked that a considerable number of flakes must be examined before it can be concluded

with certainty that a particular type of implement was present. Mr. Reid Moir's collection appeared to him to present all the characteristics which one would expect to find in a group of implements belonging to the Le Moustier culture.

Mr. Kennard said that palæontologists were firmly convinced that the Boulder Clay was of late occurrence. An examination of a continuous series of examples of the fauna exhibited no traces of the variation between warm and cold types, which would have been expected to occur if the theory of alternating warm and cold periods were correct. Fauna of the cold period were always last in the series. Mr. H. Bury said that the evidence brought forward by Mr. Reid Moir made it necessary to raise the question whether Chalky Boulder Clay was always, and wherever it occurred, of the same age. The evidence from Hoxne was diametrically opposed to Mr. Reid Moir's results, and this, together with the doubts which had been expressed as to the character of the evidence obtained from Hoxne, made it desirable that the borings on that site should be repeated.

RECENT ENGLISH MARINE BIOLOGY.

RECENT English papers on marine biological research include one by Dr. E. C. Jee on the hydrography of the English Channel during the years 1904–17. This forms part i. of the Fisheries Investigation Series III., the publication of which is now resumed by the Board of Agriculture and Fisheries. Periodicities in the physical properties of the Channel water are discussed, and correlations between these and the pilchard fisheries are apparently established. A most interesting "Contribution to the Quantitative Study of Plankton" is published by Dr. E. J. Allen in part i., vol. xii., of the Journal of the Marine Biological Association.

Plankton investigations, in so far as they have been quantitative, have been a series of approximations to a complete determination of the number of organisms of all kinds contained in a unit volume of sea-water. Hensen's original method consisted in the use of a net made of fine-meshed silk cloth which was lowered in the sea and hauled to the surface. Experiment and calculation gave a coefficient for each net, from which the area of cross-section of the column of water filtered could be approximately determined. It has been found latterly that the greater number of microscopic organisms in the water escaped through the meshes of the cloth, and more refined filtering methods were introduced by Lohmann.

Finally, it was thought that by centrifuging small quantities of water a complete enumeration of the organisms present might become possible, and this method did, indeed, largely increase the numbers inhabiting unit volume of sea-water. Why it should not enable the investigator to determine *all* is not easy to see, but it certainly under-estimates them, as Dr. Allen's results show. In his experiments small quantities of water (10 c.c.) were centrifuged and the contained organisms counted. From four such trials a mean of 14·45 per c.c. (or 14,450 organisms per litre) was obtained. The same water sample was then examined by inoculating ½ c.c. in a sterilised seawater containing the culture solutions used by Allen and Nelson for the study of marine diatoms. The inoculated medium so prepared was then distributed into seventy small flasks, each containing about 20 c.c. of the liquid, and the latter were allowed to stand for several weeks. The colonies (mainly Diatoms and Flagellates) growing in the flasks were then identified and counted, giving an estimated number of at least 464 organisms per c.c. (or 464,000 per litre). Even then it is evident that the result is an underestimate of the actual population of the water sample, for the medium is apparently selective, and organisms that appeared in the centrifuged samples did not grow (and were therefore unrecorded) in the cultures. Bacteria did grow, but were not identified and estimated. The result is therefore another, and closer, approximation to a biological value which is of extraordinary interest. J. J.

THE RED COLOURING MATTER OF PLANT GALLS.

DURING recent years our knowledge concerning plant colouring matters has rapidly increased, and quite a large number of pigments have been subjected to careful and full investigation. A further interesting contribution to our knowledge in this field of research is contained in a recent paper by Dr. M. Nierenstein, in which he deals with the colouring matter of the "red-pea gall" (Trans. Chem. Soc., 1919, cxv., pp. 1328–32). The galls that were examined occur on the leaves of various British oak-trees when galled by *Dryophanta divisa*, Adler.

It has been generally assumed that the red colouring matters of these and similar galls belonged to the anthocyan class, and one of the objects of the investigation was to ascertain whether the anthocyan assumed to be present was related to quercetin. By this means it was hoped to obtain some light upon the relationship between the products present in the normal plant and those pathologically produced as the result of the formation of the galls.

The investigation resulted in the isolation of a red pigment, to which the name "dryophantin" has been given. Dr. Nierenstein concludes that this colouring matter is not an anthocyan, but a diglucoside of purpurogallin (the first derivative of purpurogallin to be found in Nature), and that, like gallotannin, it is of pathologic origin. He is of the opinion that the other so-called anthocyans obtained from plant-galls are in all probability not anthocyan colours at all, but related to "dryophantin." In view of this he proposes to classify these red pigments under the class-name "gallorubrones."

This paper is of considerable interest, particularly if further investigation confirms the presence of purpurogallin derivatives as regular constituents of these and other red galls. In respect of the conclusion implied as to the absence of pigments of the anthocyan group, the present paper is not sufficient evidence of such absence, for the process whereby the colouring matter has been isolated is such that there is a very considerable doubt whether many anthocyan pigments would survive the treatment.

IONS AND IONISATION.

THE Faraday Society, though a small body, is very active. One of the most useful features of its activity is the holding of general discussions on matters of scientific and technical interest, and the publication of these discussions in its Transactions. "The Present Position of the Theory of Ionisation in Solution" was the subject of a discussion held on January 21, 1919, and the report is now issued in the form of a separate reprint (pp. 178, Faraday Society, 10 Essex Street, Strand, W.C.2, price 12*s.* 6*d.*), thus making it available to a larger public than the members of the society.

The discussion was opened by Dr. Senter, who briefly reviewed the position with regard to such outstanding problems as the hydration of ions, the deviation of strong electrolytes from the mass-action law,

and the chemical activity of ions and non-ionised molecules respectively. Communications on these and other topics were afterwards read and discussed, amongst the contributors or those taking part in the discussion being Arrhenius (the originator of the theory), Acree, McBain, Bousfield, Sand, Partington, Porter, Newbery, Lindemann, Philip, and J. C. Ghosh.

Fundamental differences of opinion with regard to the main problems discussed were very marked. The evidence for the hydration of ions is by some held as final, by others as having only a limited application, and by yet others as quite inconclusive. Most attention was given to the problem of the abnormality of strong electrolytes. At extreme dilutions these electrolytes are regarded by many as behaving normally, the dissociation constant for uni-univalent electrolytes being about 0·02, but owing to the magnitude of the water-correction, and the difficulty of exactly fixing the molar conductivity for infinite dilution, this result must still be looked upon as uncertain. At ordinary dilutions the law has no application, and the most promising explanation is that elaborated by Dr. J. C. Ghosh, who proceeds on the assumption that the strong electrolytes are practically completely ionised in all dilute solutions, but that there is an electrostatic equilibrium between mobile ions, which contribute to the conductivity, etc., and inert ions, which do not. An electrical dilution law is therefore substituted for the chemical mass-action law in the case of strong electrolytes. For weak electrolytes this electrical action would only enter as a negligible disturbing factor of the mass-action law. The further development of this idea may be awaited with interest.

THE SPECIES CONCEPT AMONG FUNGI.

IN the Transactions of the British Mycological Society (vol. vi., part ii., September, 1919) Mr. W. B. Brierley protests against the practice of mycologists in describing as species the forms which are presented to them in Nature or as pathological growths, especially on cultivated plants. The description of new fungal species is based on the assumptions that the distinguishing characters are of a morphological nature, and that the essential specific characters are constant and hereditary and may be determined in one specimen of one generation. But the laboratory and field experience of the experimentalist shows that under changes in the environment the whole structure and facies of the organism may be transformed, while under identical conditions there is considerable evidence that the morphological variation of a particular fungus is definite and constant. The so-called species of the mycologist is comparable with the "ecad" of the ecologist, and is the resultant of the organism and its environment. "Ecads" indistinguishable from each other may be produced from two distinct organisms interacting with one and the same environment, or with two different environments. Two precisely similar fungi growing on a potato and a decaying tree-stump respectively may really be different species, though the systematic mycologist would consider them identical. The true organism is a physiological equilibration, a metabolic entity, the interaction of which with the environment results in the growth-form or "ecad." It follows that the morphological species concept must be given up in favour of the physiological species concept. The only exact method of determining species is by means of quantitative data derived from cultural treatment under standardised physico-chemical conditions, for this method alone reveals the physiological condition of the organism. The author suggests that even the apparently stable forms of the higher fungi, Agarics, Polypores, etc., are merely "ecads," and that two precisely similar morphological entities of, for instance, *Agaricus melleus* may conceal totally different physiological constitutions which under other conditions of growth would diverge characteristically.

Mr. Brierley also attacks another concept of mycology, namely, the "educability" of fungi, or the induction by suitable treatment of permanent modifications in their biochemical, morphological, or other properties. This concept is widely held by microbiologists, but if it implies a possibility of a change in the physiological constitution of an organism, it follows that with fuller knowledge and improved technique a rapid change of one species into another is possible. The author affirms that the condition of knowledge and the available evidence are not such as to warrant an hypothesis so subversive of the foundations of biological science. The presumed mutations may be due to the presence of mixed populations in supposed pure cultures, or merely the expression of a developmental stage previously unrecognised; further, no organism in which sexuality exists or is conceivable must be used unless its gametic constitution and genetic behaviour under all the conditions of the experiment are known.

THE UPPER LIMIT OF UNPLEASANT BEATS.

IT is well known that Helmholtz traced all discordant effects of two or more musical notes when sounded together to the presence of beats occurring between the prime tones, between the prime of one and an upper partial of the other, between the upper partials of each, or to beats occurring in some other way. Further, to produce the unpleasantness in question the beats must lie between certain limits of frequency, which limits vary with the pitch in use.

In this connection it is of interest to note that Mr. Narendranath Chatterjee, of Chittagong, India, has recently given a formula expressing the upper limiting frequency for beats for which the roughness vanishes. This formula he writes as follows:

$$B = \frac{N}{0{\cdot}7 + n + i}, \quad \ldots\ldots (1)$$

where B is the number of beats per second for which the roughness vanishes, N is the frequency of the lower of the two tones sounded simultaneously, n is the number of the musical scale containing N and beginning with 32 per second as the fundamental of the first scale (the octave of this being the fundamental of the next scale, and so on), and, finally, i is the interval between N and the fundamental of the scale in which it is contained.

Thus N, n, and i are connected by the equation

$$N = 32 \times 2^{n-1} \times i \quad \ldots\ldots (2)$$

The results of the law compared well with Mayer's experimental values, as shown in the following table:

Frequency N of lower tone	Frequency B of beats when roughness vanishes	
	Mayer's values	Results of law
64	16	17
128	26	27
256	47	45
512	78	76
1024	135	133

RESEARCHES AT HIGH TEMPERATURES AND PRESSURES.

BY THE HON. SIR CHARLES A. PARSONS, K.C.B., F.R.S.[1]

II.

THE calories evolved in the combination of graphite and oxygen are about 0·5 per cent. less than those evolved in the combination of diamond and oxygen, indicating that graphite at ordinary temperature is, to this extent, a stable state. The bulk-pressure which has operated in some of the experiments would, however, seem to have been amply sufficient to turn the balance in favour of diamond instead of graphite. The uncertainty, on the other hand, as to the compressibilities and specific heats of the allotropic forms of carbon under high pressures and at high temperatures renders speculation of little value as to what may occur at the melting point of carbon. All we know is that, up to the pressures and temperatures reached in our experiments, no indication of a change from graphite to diamond has been produced. In one experiment very intense heating was applied for five seconds, but sufficient in amount to melt the graphite core six times over, the only result being a slight alteration in the structure of the graphite. The barrier in this experiment was calcined magnesia, and the hole in it was superficially converted to magnesium carbide. It appeared, however, desirable further to investigate the possibility of carbon losing its electrical conductivity when approaching its melting point, as alleged by Ludwig and others, and of shunting the current from itself on to the contiguous molten layers of the insulating barrier surrounding it. There had been no indication of such a change having occurred even momentarily; it rather seemed that the graphite core had been partially vaporised and condensed in the cooler parts of the charge. The experiment was repeated with rods of iron and tungsten embedded in the core, so that should the temperature of volatilisation of the metals under a pressure of 15,000 atmospheres exceed that necessary to liquefy carbon under the same pressure, the presence of these metals might produce a different result. No change, however, occurred.

Note.—The temperatures at which carbon, iron, and tungsten volatilise under a pressure of 15,000 atmospheres are unknown, but they are probably much higher than at atmospheric pressure.

This experiment also tested iron as a solvent of carbon and as a catalyst from diamond to graphite under a pressure of 100 tons, and showed that under this pressure that action was not reversed.

Fig. 3 shows the container arranged for treating powders by resistance heating with or without the addition of liquids or gases. The electric current is conveyed from the container to the upper end of the conductor by a layer of graphite which rests on the charge under treatment. The bottom end of the conductor rests on or is spigoted into a cast-iron block which rests on the bottom pole; this block is sometimes partially melted, but can be easily renewed.

The container is charged by first stemming magnesite powder by hand around the bottom pole-piece and block; then the charge is placed on the top and pressed to 5 tons per square inch; the top ram is then removed, a hole drilled through the charge, and the conductor inserted. Liquids, if used, or carbon dioxide snow may then be introduced; lastly, a layer of graphite is placed on the top, and the whole pressed to the desired pressure for the experiment.

[1] Discourse delivered at the Royal Institution on Friday, January 23. Continued from p. 681.

In one experiment several pounds of carbon dioxide snow were added to the charge, which consisted of magnesia, and was so arranged that evaporation of the heating carbon rod took place in an atmosphere of carbon dioxide and carbon monoxide under a gaseous pressure of 4400 atmospheres, the condensate resulting being soft graphite. Upwards of two hundred chemical reactions arranged to deposit carbon were tested under high pressure and central heating. After each experiment samples were taken from various parts of the charge and carefully analysed for diamond, the methods of the analyses generally following those of Moissan and Crookes. On the whole, there was no evidence that diamond had been produced by any of the chemical reactions, some of which were endothermic, such as carborundum and sodium carbonate, which produced a grey solid which detonated when struck with a hammer, and nearly caused a serious accident. In one experiment the charge was olivine and water; when molten under 10 tons per square inch the pressure was suddenly removed, and artificial pumice was formed by the expansion of water-vapour absorbed by the olivine when molten.

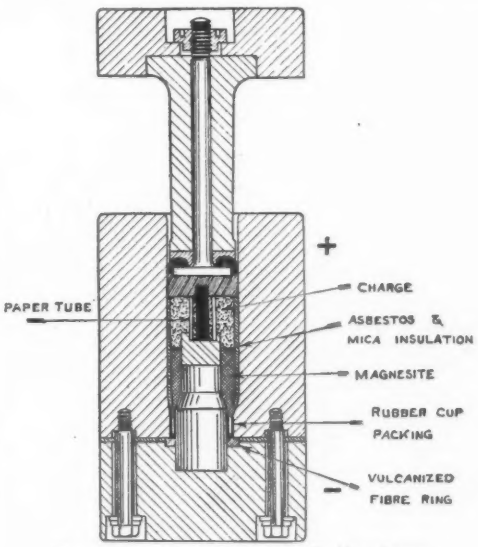


FIG. 3.—For powders with or without liquids and gases.

Having nearly reached the limits of steady pressure obtainable in steel containers under a press, experiments with impact pressures produced by steel bullets were tried, which produced much higher instantaneous pressures than are obtainable in any die.

A rifle, 0·303-in. bore, was arranged for withstanding a charge of cordite 90 per cent. in excess of the Service charge. The gun (Fig. 4) was fixed with its muzzle 6 in. from a massive block of steel, in which a hole 0·303 in. in diameter had been drilled to a depth somewhat greater than the length of the bullet, and in alignment with the bore of the gun; cylindrical bullets of steel with a copper driving band were chiefly used, shorter than the Service bullet and about one-half the weight. The substance to be compressed was placed either at the bottom of the hole, when a conical-nosed bullet of mild steel was used, or over the mouth of the hole, when a cupped-nosed bullet of tool-steel was employed. About a hundred experiments were made.

The substances tested included graphite, sugar-carbon, bisulphide of carbon, oils, etc., graphite and sodium nitrate, graphite and fulminate of mercury, finely divided iron and fine carborundum, olivine and graphite, etc. After each shot the bullet and surrounding steel were drilled out, and the chips and entrained matter analysed. Fig. 5 shows the bullet in the hole after firing.

Several experiments were also made with a bridge of arc-light carbon placed over the hole and raised

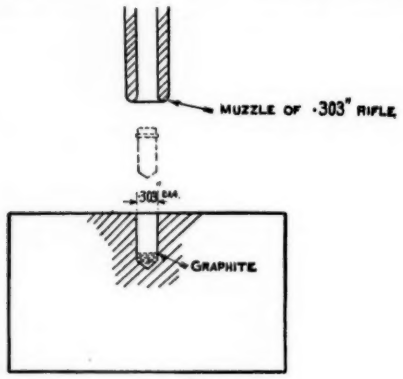


FIG. 4.

to the limit of incandescence by an electric current, and the shot fired through it into the hole at the moment the carbon commenced to vaporise, as observed in a mirror from without. Also, an arc between two carbons was arranged to play just over the hole and the shot fired through it (Fig. 6). The residues were in all cases exceedingly small, and there was no evidence of any incipient transformation of carbon in bulk into diamond that could be detected by analysis.

The pressure on impact of a steel bullet fired into

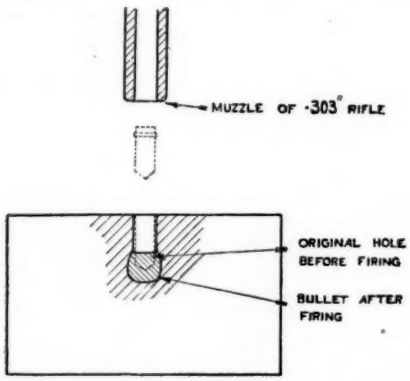


FIG. 5.

a hole in a steel block which it fits is limited by the coefficient of compressibility of steel; with a velocity of 5000 foot-seconds it is about 2000 tons per square inch. Measurements made from a section through the block and bullet (Fig. 5) showed that the mean retardation on the frontal face after the impact until it had come to rest was about 600 tons per square inch. Several experiments were made by substituting a tungsten steel block hardened and tempered, and a hole tapering gently from 0·303 in. at the mouth to 0·125 in. at the bottom. The mild steel bullet was deformed by the tapered hole, which greatly increased the velocity imparted to the nose. Progressively increased charges were used. With the 90 per cent. excess charge the block always split on the first shot, but this probably occurred after impact, and not until the full instantaneous pressure had been exerted, which was probably about 5000 tons per square inch, or about equal to that at the centre of the earth.

It would be interesting to repeat some of these experiments on a larger scale. With a projectile of 6 in. or 9 in. in diameter and a velocity of 5000 foot-seconds, the instantaneous pressure would be the same, but its duration (which is proportional to the linear dimensions) would be increased from twenty- to thirty-fold. It has been estimated that the rise in temperature due to adiabatic compression of incandescent carbon when subjected to 2000 tons per

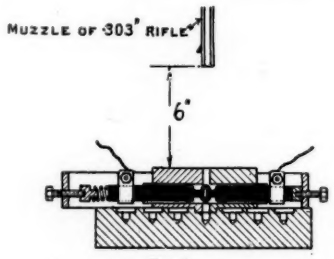


FIG. 6.

square inch is of the order of about 1000° C., so that actual melting of the carbon would probably have occurred when the shot was fired through the incandescent carbon bridge.

Another experiment was arranged which would ensure that carbon should be subjected to an extremely high temperature concurrently with a high pressure obtained by the rapid compression of the hottest possible flame, that of acetylene and oxygen, with a slight excess of the former to provide the carbon. The arrangement was as follows (Figs. 7 and 8):—A very light piston made of tool-steel was carefully fitted to the barrel of a gun of 0·9 in. bore; the piston was flat in front, lightened out behind, and fitted with a cupped copper gas-check ring, the cup facing forward; the total travel of the piston was 36 in. To the

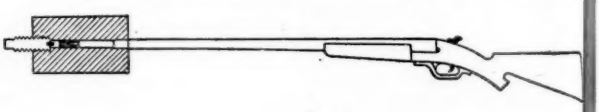


FIG. 7.

muzzle of the gun was fitted a prolongation of the barrel formed out of a massive steel block, the joint being gastight; the end of the bore in the block was closed by a screwed-in plug made of tempered tool-steel, also with a gastight collar. A small copper pin projected from the centre of the plug to give a record of the limit of travel of the piston. The gun was loaded with 2 drams of black sporting powder, which amount had been calculated from preliminary trials. The barrel in front of the piston was filled with a mixture of acetylene and oxygen. It was estimated that this mixture would explode when the piston had travelled about half-way along the bore. When fired, the piston travelled to within $\frac{1}{8}$ in. of the end, as had been estimated, giving a total compression ratio

of 288 to 1. As a result, it was found that the surfaces of the end plug, the fore end of the piston, and the circumference of the bore up to ⅜ in. from the end of the plug had been fused to a depth of about 0·01 in., and were glass-hard; the surface of the copper pin had been vaporised, and the copper sprayed over the face of the end plug and piston. The end plug, which had been hardened and tempered to a straw colour, showed signs of compression, and the bore of the block for ⅜ in. from the plug was enlarged by 0·023 in. in diameter, both indicating that a pressure above 100 tons per square inch had been reached. A little brown amorphous carbon was found in the chamber, which was easily destroyed by boiling sulphuric acid and nitre. There was no diamond residue from this. Considering the light weight of the piston and the very short duration of the exposure to heat, the effects would indicate that a very abnormal temperature had been reached, many times greater than exists in the chambers of large guns. A calculation made by Mr. Stanley Cook, based upon the ratio of compression and a final pressure of 15,000 atmospheres, indicates that a temperature of between 15,250° and 17,700° C. was reached, the exact temperature depending upon the amount of dissociation or combination existing between the elements at the time.

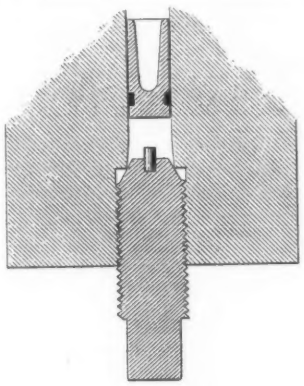


FIG. 8.

Calculation of the Temperature Reached on the Compression of Acetylene and Oxygen Experiment.

By STANLEY S. COOK.

The temperature reached may be estimated from the final pressure, which the observed deformation of the block and plug indicates to have been in the neighbourhood of 100 tons per square inch. But it must be remembered that there is a change of molecular volume as a result of combustion. Thus the mixture, which as C_2H_2 and 5(O) has 3½ molecular volumes, would on combustion to $2CO_2$ and H_2O have only 3 molecular volumes. The final temperature deduced from the pressure will therefore depend upon the extent to which chemical combination has taken place.

The original mixture being at atmospheric pressure and at a temperature of 290° C. absolute, a pressure of 100 tons per square inch, after compression to 1/288th of its original volume, would indicate a temperature of 15,250° C. If, however, complete combustion has taken place, this pressure would correspond to a temperature greater in ratio of 3½ to 3, viz. to 17,700° C. The actual temperature must therefore have been something between these two values.

Let us for a moment consider the pressures and temperatures possible in Nature (in this I am indebted to kind assistance from Prof. Jeans). The pressure at the centre of the earth is between 4000 and 10,000 tons per square inch, according to the variation in density of the concentric layers.

Emden has estimated the probable pressure at the centre of the more massive component of the binary star S Hercules to be 360,000,000 tons per square inch.

Again, the densities of the brighter components of certain binary stars are estimated by Öpik to be about that of iron, and if we assume that their diameter is the same as that of the sun, that each has an initial velocity in space not greater than 30 miles per second, and that they directly collide, then, owing to their mutual attraction, Jeans calculates that their velocity will have increased to 450 miles per second, and that the pressures in the centre as they strike and flatten would be of the order of 1,000,000,000 tons per square inch. He also estimates that the heat equivalent of the energy would be sufficient to vaporise the whole mass 100,000 times over. This immense pressure would be maintained for many minutes, perhaps for half an hour.

Let us consider what is the greatest pressure that can be produced artificially. If the German gun which bombarded Paris were loaded with a solid steel projectile somewhat shorter and lighter than the one actually used, a muzzle velocity of about 6000 foot-seconds might be reached (many years ago Sir Andrew Noble had reached 5000 foot-seconds); and if it was fired into a tapered hole, as I have described, in a large block of steel, this would give the greatest instantaneous pressure that can be produced artificially so far as we at present know, viz. about 7000 tons per square inch: it is only about 1/150,000th part of that possible by the collision of the largest stars.

As to the temperature and conditions of matter under these intense pressures, extrapolation from known data is valueless. We have no knowledge of the coefficients of compressibility of matter under these conditions or of its specific heat. What may be the effect on the atom? And will elements under such conditions be transformed into others of higher atomic weight?

Some of us may recall that in 1888 a lecturer, after describing in this room the experiment in which oxygen at atmospheric pressure was passed in close contact with a platinum surface heated by the oxy-hydrogen burner to nearly its melting point, and then immediately cooled by contact in water, said:

"In this experiment ozone is formed by the action of a high temperature, owing to the dissociation of the oxygen molecules and their partial recombination into the more complex molecules of ozone. We may conceive it not improbable that some of the elementary bodies might be formed somewhat like the ozone in the above experiment, but at very high temperatures, by the collocation of certain dissociated constituents and with the simultaneous absorption of heat."

It seems indeed probable that the centres of the great stars and stars in collision may be the laboratories where the elements as they gradually degenerate are being continually regenerated into others of higher intrinsic energy, and where endothermic processes, such as the recombination of lead and helium into radium, may be taking place, absorbing in this process an energy 2,500,000 times that developed by the explosion of an equal weight of T.N.T.

The transformation of only a minute fraction of the mass of two colliding stars would therefore be amply sufficient to absorb the whole energy of their collision.

Emerson said many years ago, "None but the elements can themselves destroy."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ABERDEEN.—The honorary degree of LL.D. is to be conferred on Sir J. C. Bose, founder of the Bose Research Institute, Calcutta; Prof. W. Bulloch, professor of bacteriology, London Hospital; Prof. J. Wight Duff, Armstrong College, Newcastle-upon-Tyne; Sir Daniel Hall, Permanent Secretary to the Board of Agriculture; Mr. J. H. Jeans, secretary of the Royal Society; and Sir Robert Jones, lecturer on orthopædic surgery, Liverpool University.

CAPT. JAMES W. LOW has been appointed assistant in the natural history department, University College, Dundee (University of St. Andrews).

APPLICATIONS are invited for the Radcliffe Crocker travelling scholarship in dermatology at University College Hospital Medical School. The scholarship is of the approximate value of 280*l.*, and tenable for one year. Particulars are obtainable from the Dean, University College Hospital Medical School, Gower Street, W.C.1.

THE next election—the seventh—to Beit fellowships for scientific research will take place on or about July 15 next. The latest time for receiving applications is April 19. Forms of application and information respecting the fellowships are obtainable, by letter, from the Rector, Imperial College of Science and Technology, South Kensington.

A MOVEMENT has been started to form a properly constituted Old Students' Association at King's College, London. A committee has drawn up a provisional constitution, and a general meeting has been called for March 4, at 6 p.m., at the college. It has been possible to send notices of this meeting only to those old students whose names are on the register, but it is hoped that the meeting will be made widely known, and that as many old students as possible will be present.

THE first meeting of the International Federation of University Women, which will include delegates from the women's colleges throughout the world, will meet in London in July next. The chairmen of the International Federation are Dean Virginia Gildersleeve, of Barnard College, Columbia University, U.S.A., and Prof. Winifred Cullis, of the London (Royal Free Hospital) School of Medicine for Women, University of London.

THE Chadwick Trustees announce three public lectures on "Military Hygiene in Peace and War," by Gen. Sir John Goodwin, K.C.B., in the lecture-room, Royal Society of Arts, John Street, Adelphi, W.C.2, on Mondays, March 8, 15, and 22, at 5.15 p.m. The titles of the lectures are:—Army Hygiene prior to the Recent War, Army Hygiene during the Recent War (Application of its Principles to Active Service Conditions), and The Future of Army Hygiene (Its Relation to the Hygiene of the Civil Community). All information about Chadwick public lectures may be obtained from the secretary, Mrs. Aubrey Richardson, at the offices of the Trust, 40 (6th) Queen Anne's Chambers, Westminster, S.W.1.

THE opening of the British Bureau of the Office National des Universités et Ecoles Françaises at 50 Russell Square by M. Lucien Poincaré took place on Monday, February 23, in the presence of many distinguished university men of both countries. The bureau is intended to serve as a university *liaison* office between the two countries, giving advice to British students who may wish to study abroad or French students seeking to pursue their studies in England, and so bringing British and French universities into closer touch with one another. M. Poincaré, in declaring the bureau open, said the work which would be done in Russell Square would be of the greatest use, particularly to England and France. He hoped the day would come when all Englishmen would speak French and all Frenchmen would speak English. It was too early, he thought, to say we were internationalists, using the word in its better meaning. We were rather inter-Allies. It was still necessary to struggle for civilisation. He trusted that the Office National would be a powerful factor in uniting England and France in closer bonds and for working for the good of humanity. In the evening, M. Millerand, the Prime Minister of France, in the chair, a dinner given by the Groupe Inter-Universitaire Franco-Britannique was held at the Connaught Rooms in honour of M. Poincaré and to celebrate the formal opening of the bureau. Many public men were present, and the general trend of the speeches during the evening was to emphasise the possibility of this alliance of the universities helping to cement the already established union between France and England.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 12.—Sir J. J. Thomson, president, in the chair.—J. W. **McBain** and C. S. **Salmon**: Colloidal electrolytes. Soap solutions and their constitution. For the first time a comprehensive theory of soap solutions has been set up. This has led to a definition of colloidal electrolytes, a class the members of which will probably prove more numerous than acids and bases put together. They are salts in which one of the ions has been replaced by an ionic micelle. The ionic micelle in the case of soap exhibits an equivalent conductivity equal to that of potassium ion, and double that of the palmitate ion which it has replaced. Its formula may correspond to $(P')_n . m(H_2O)$, but more probably it is $(NaP)_x(P')_n . (H_2O)_m$, where P′ is the anion of the fatty acid in question. In concentrated solutions soaps exist chiefly in colloidal form, together with sodium or potassium ion, equivalent to the ionic micelle present, whereas in dilute solution both undissociated and dissociated soaps are crystalloids of simple molecular weight. In mixtures of soaps the tendency is to form more micellæ. Addition of electrolytes, however, exerts opposing influences, dehydrating and driving back dissociation. The conception of the ionic micelle serves to explain the behaviour of solutions of dyestuffs, indicators, and proteins. A modification of the dew-point method is described, which has enabled measurements of osmotic activity and "molecular weight" to be carried out, free from the uncertainties of interpretation of the results obtained for colloids by the osmometer method, and superseding the well-known but erroneous data of Krafft.—C. C. **Farr** and D. B. **Macleod**: The viscosity of sulphur. The results are discussed of a number of experiments, under a great variety of conditions, on the viscosity of sulphur with temperatures rising and falling between 123° C. and 278° C. The method employed was that of rotating cylinders, usually with a bifilar suspension. A unifilar suspension was, however, employed in the neighbourhood of the point of minimum viscosity. Great care was taken to secure that the sulphur had actually attained the temperature indicated by the thermometer used. The effects were observed of prolonged heating, also the effects of the absorption of gases, especially NH_3 and SO_2. The relation of the viscosity to the amount of "insoluble sulphur" present is considered.—C. V.

Raman and B. **Banerji**: Kaufmann's theory of the impact of the pianoforte hammer.—Comdr. T. Y. **Baker** and Prof. L. N. G. **Filon**: A theory of the second order longitudinal spherical aberration for a symmetrical optical system. The authors obtain a formula for the longitudinal spherical aberration in a symmetrical optical system of the type

$$\Delta x = (At^3 + Et^5)/(1 + Bt^2),$$

where Δx is the longitudinal spherical aberration on the axis, t is the slope to the axis of the emergent ray calculated by Gauss's method, and A, B, E are polynomials in the magnification of degrees 4, 3, and 6 respectively. It is shown (1) that a formula of this kind is, on the average, superior in numerical accuracy to the first two terms of the usual series of aberrations of successive order; and (2) that it removes a number of difficulties connected with convergency which occur in the methods at present in use. In particular, developments in powers of trigonometrical functions of the true inclination of the emergent ray are shown to be unsatisfactory. Certain invariant relations are obtained, connecting A, B, and E in general, and facilitating their computation. Formulæ are found enabling the functions A, B, and E to be calculated for a combination of lenses when the corresponding functions for the individual lenses are given, and a method is indicated whereby the contribution of each lens to the final image defects can be rapidly traced.—Prof. J. W. **Nicholson**: The lateral vibrations of sharply pointed bars. The paper is a sequel to one already published, which arose from a suggestion as to the formation of siliceous deposits on sponge-spicules of a certain type. The present paper deals with an exceptional case, for which the necessary analysis presents unusual features. It is that of a double rod each half of which is generated by rotation of the parabola $y = Ax^2$ about the axis of x. The influence of sharpness on the frequencies and nodal positions of the notes is traced numerically after the general analysis. It is shown that a limiting frequency and nodal position exist, so that the frequency is a lower limit to those producible under any conditions of support. As the rod becomes sharper all its frequencies tend to this value, while of the nodes one for each frequency tends to a definite position, and all the others to the extreme ends of the rod. The same conclusions apply to a single rod.—R. E. **Slade** and F. C. **Toy**: A new method of spectrophotometry in the visible and ultra-violet and the absorption of light by silver bromide. A new method of measuring the absorption of light by a substance has been devised. This method is independent of the relation between density and exposure of the photographic plate. The following values of the extinction coefficient of silver bromide at various wave-lengths have been determined:

λ		k	λ		k
450 $\mu\mu$	...	270	400 $\mu\mu$	...	2000
440 ,,	...	410	390 ,,	...	2790
430 ,,	...	600	380 ,,	...	3800
420 ,,	...	900	370 ,,	...	5100
410 ,,	...	1380	360 ,,	...	6700

This extinction coefficient is defined by the formula

$$I_2 = I_1 e^{-kd},$$

where I_1 and I_2 are the intensities of the light at points d centimetres apart in the absorbing medium. It is estimated that the average error of any of these values is less than 3 per cent.—Dr. S. **Chapman**: A note on Dr. Chree's discussion of two magnetic storms.—Dr. C. **Chree**: An explanation of the criticisms on Dr. Chapman's recent paper, "An Outline of a Theory of Magnetic Storms."

Linnean Society, February 5.—Dr. A. Smith Woodward, president, in the chair.—Dr. R. Ruggles **Gates**: The existence of two fundamentally different types of characters in organisms. The experimentalist point of view regarding evolution, resulting from the work in mutation and Mendelism, is frankly antagonistic to the views of palæontologists, anatomists, and others who deal with orthogenesis and the inheritance of acquired characters. While these two factors bear entirely different relations to evolutionary changes, both are necessary to account for evolution as it has taken place. The conclusion is reached that higher organisms exhibit two contrasted types of characters, which differ fundamentally (1) in their manner of origin, (2) in their relation to the structure of the organism, (3) in their relation to such phenomena as recapitulation, adaptation, and inheritance, and (4) in their relation to geographic distribution. To the first category belong cell-characters, which arise as mutations, are represented in every cell of the individual, and are usually inherited as distinct entities. To the second category belong organismal characters, which arise gradually through impact of the environment or through orthogenetic changes, may modify only localised portions of the life-cycle, and may not be incorporated in the germ-plasm from the first.

Zoological Society, February 10.—Prof. E. W. MacBride, vice-president, in the chair.—H. R. **Hogg**: Some Australian Opiliones. The genera and species described belonged to the sub-orders Palpatores and Laniatores, the Palpatores being represented by the genera Pantopsalis and Macropsalis of the family Phalangiidæ, and the Laniatores by genera of Triænobunidæ and Triænonychidæ. In the case of the Phalangiidæ the author had been able to establish that long mandibles were a male and short mandibles a female character.—Dr. C. F. **Sonntag**: Larynx and œsophagus of a common macaque, exhibiting several unusual features.—R. E. **Turner** and J. **Waterston**: A revision of the Ichneumonid genera Labium and Pœcilocryptus.

Physical Society, February 13.—Prof. C. H. Lees, president, in the chair.—Prof. C. H. **Lees**: Presidential address: The temperature of the earth's interior. In an average cubic centimetre of matter within the earth's substance the energy generated by radio-active matter is equivalent to the sum of the following quantities: (1) Heat utilised in rise of temperature, (2) loss of heat by conduction, etc., (3) change in gravitational energy, and (4) thermal stress. The only factor known with certainty is the loss by conduction, which works out to an average of 10 ergs per annum per c.c. The approximate water equivalent of the material of the earth is 0·8; therefore a rise of temperature of 1° C. requires 33,000,000 ergs. Hence, if there was nothing to take into account but the conduction loss, the temperature would fall by 1° in 3·3 million years. The discovery of radio-activity, however, showed that near the earth's surface the average amount of energy radio-actively generated is 1000 ergs per c.c. The quantity falls off rapidly as deeper rocks are reached. The present Lord Rayleigh suggests that the average may be about 10 ergs—just sufficient to balance the heat lost from the surface. If we accept this theory, we have to deal with a steady state, in which the temperature neither rises nor falls, and the calculation of the temperature at points inside the mass is simple. The equilibrium theory has been much criticised, however, and it is necessary to consider other alternatives. There are two possibilities: Either the temperature may be rising, due to the radio-energy exceeding the surface loss, or it may be falling if the balance is the other way. The geological evidence

renders the first contingency highly improbable. For a rate of change of temperature of 1° per million years the change in thermal energy involved is 33 ergs per annum per c.c., while the change in gravitational energy is 20 ergs per annum per c.c. These quantities can be lumped together and regarded as one by assuming the water equivalent of the earth's substance to be 1·6 times its actual value. Thus, neglecting radio-active effects, the time taken to cool 1° would be 5·4 million years instead of 3·3 million, as calculated without taking gravitational energy into account. From the relative amounts of lead and uranium found in rocks it has been calculated that the time which must have elapsed since the formation of the crust is of the order of 1,000,000,000 years. The temperature of solidification was probably about 1300° C., so we have the data necessary to give the present rate of cooling. From this, for any assumption regarding the actual distribution of radio-active material, the temperature at points within the earth can be determined.—Sir Arthur **Schuster**: The influence of small changes of temperature on atmospheric refraction. The paper is an investigation of the possible deviation of the light from a star near the sun due to the temperature changes in the atmosphere produced by the passage of the moon's shadow across the earth during an eclipse. It is shown that while the actual displacements from this cause vary widely for slight differences in the assumed conditions, they are always negligibly small compared with the effects observed at the last solar eclipse.

Royal Meteorological Society, February 18.—Mr. R. H. Hooker, president, in the chair.—Capt. C. J. P. **Cave**: The status of a Meteorological Office and its relation to the State and to the public (see p. 705).—W. H. **Dines**: Atmospheric and terrestrial radiation. The author endeavours to follow the flow of radiant energy, other than solar, both upward and downward across any horizontal plane in the atmosphere. Certain theoretical assumptions are made to render the calculation possible, and it is shown that the curves that represent the net loss or gain of heat from strata at different heights are all more or less of the same character, whatever possible values are ascribed to the emissivity of the various strata. It is found that over Europe the air from the earth's surface up to about 8 km. is losing heat by radiation, and that from 8 km. to 12 km. it is gaining heat, losing it again at more than 12 km. The validity of the assumptions made is then discussed, and it is pointed out that the numerical values agree well with those obtained by entirely different means.—D. **Brunt**: Internal friction in the atmosphere. When a steady state of motion is assumed, any portion of the atmosphere is in equilibrium under the action of three forces: the gradient of pressure, the deflecting force at right angles to its motion, and the frictional force. The first two of these are measurable, and so the third can be evaluated. The paper gives a comparison of the frictional force calculated in this manner, with the values derived from a theoretical discussion of turbulent motion. A new derivation of the solution of the equations of motion is given. Use is made of observations at the top and base of the Eiffel Tower to derive the value of the coefficient of eddy viscosity. An additional note shows that a solution of the equation of motion is possible in cases where the coefficient of eddy conductivity varies with height.

CAMBRIDGE.

Philosophical Society, February 9.—Mr. C. T. R. Wilson, president, in the chair.—F. W. **Aston**: The mass spectra of the chemical elements. By means of a special arrangement of electric and magnetic fields it is found possible to bring positive rays of definite mass to a focus, independent to some extent of their velocity, so that the dispersion can be made much greater than hitherto without loss of intensity. In this way a mass spectrum is formed on which the values of mass can be compared, in favourable cases, to an accuracy of about one part in a thousand by comparison with known reference lines such as O (16), C (12), etc. In this way atmospheric neon is definitely proved to consist of two isotopes of mass 20 and 22. Argon gives a line exactly at 40, and if it is a mixed element the other constituents must be present in very small proportion. Chlorine gives a group of four lines exactly at 35, 36, 37, and 38, and others from which good evidence can be adduced that this element consists of at least two isotopes, Cl^{α} (35) and Cl^{β} (37), (36) and (38) being the two corresponding hydrochloric acids. Mercury is also found to be a mixture of isotopes, probably three in number, their masses not yet being accurately determined. Very interesting results are yielded by helium and hydrogen; the former appears to be a "pure" element of mass 4·00, but hydrogen is very definitely heavier than unity (O=16. H_1, H_2, and H_3 all give consistent values in approximate agreement with that accepted by chemists: 1·008 for hydrogen. When due allowance has been made for multiple charges, it is found that of more than fifty atomic and molecular masses so far determined, every one, with the exception of the three hydrogen lines, falls on a whole number within the error of experiment.—K. **Molin**: An examination of Searle's method for determining the viscosity of very viscous liquids.—H. W. **Richmond**: Note on the Diophantine equation $t^3+x^3+y^3+z^3=0$.—Prof. H. F. **Baker**: Mathematical notes: (1) The stability of rotating liquid ellipsoids; (2) the general theory of the stability of rotating masses of liquid; (3) the stability of periodic motions in general dynamics; (4) the invariance of the equations of electrodynamics in the Maxwell and in the Einstein forms; (5) a property of focal conics and of bicircular quartics; (6) the Hart circle of a spherical triangle; (7) a proof of the theorem of a double six of lines by projection from four dimensions; (8) a group of transformations of rectangular axes; (9) transformations with an absolute quadric; and (10) the reduction of homography to movement in three dimensions.

EDINBURGH.

Royal Society of Edinburgh, January 12.—Prof. F. O. Bower, president, in the chair.—Prof. W. **Peddie**: The atomic space lattice in magnetite. The question of the uniqueness of the determination by the X-ray method was discussed. It appears that the solution is probably not unique within the limits of accuracy in observation.—J. **Marshall**: An unnoticed point in the theory of Newton's rings. By consideration of the passage of light-waves through three media the author discussed the considerations under which the centre of the rings was a black spot or a bright spot. These depend upon the relative refractive indices of the three materials. It was shown that the reason why Brewster obtained a bright spot at the centre with an appearance of interference rings was because the refractive indices of his materials were approximately in geometrical progression.—A. T. **Doodson**, R. M. **Carey**, and R. **Baldwin**: Theoretical determination of the longitudinal seiches of Lake Geneva. The essential feature of this paper was the development of a mathematical method (due to J. Proudman) of successive approximations by which the nodes of seiches in irregular-shaped basins can be calculated. The method was applied to the seiches of Lake Geneva with satisfactory results.

February 2.—Sir George A. Berry, vice-president, in the chair.—Dr. C. G. **Knott** and Miss **Dallas**: Magnetic strains in nickel-steel tubes. The material was the usual commercial nickel-steel with 2·63 per cent. of nickel. The four tubes were cut down from the same bar, being all of equal length and equal width, and the bores were ¼, ½, ¾, and 1 in. in diameter. The changes in the length of each tube in various fields were measured, as were also the corresponding changes in volume of the bore of the material and in the external form when the bores were plugged so that the tubes were in appearance solid cylinders; and from these measurements the values of the several linear dilatations in these fields were calculated. The longitudinal dilatation was always positive, attaining a value of from $3{\cdot}5\times10^{-6}$ to nearly 5×10^{-6} in field 500. The corresponding radial and tangential dilatations were negative, and ranged from $-1{\cdot}3\times10^{-6}$ to $-2{\cdot}4\times10^{-6}$. The results indicate that a spherical element becomes ellipsoidal or spheroidal, with the longest axis along the axis of the tube. If the effect is to be explained in terms of the orientation of magnetic molecules, then these molecules tend to set with their longer axes along the lines of magnetisation. In former experiments with iron and steel the longitudinal dilatation changed sign from positive to negative in fields of about 300 to 400. In nickel, again, the longitudinal dilatation was always negative and about eight or ten times larger than in the case of either iron or steel. In nickel-steel the dilatation remained positive up to the highest fields used (about 900), although in three of the tubes it passed its maximum in field 400 or 500. So far as magnetic strains are concerned, the small admixture of nickel does not impart to the alloy any nickel characteristic whatever.—Prof. W. **Peddie**: The adequacy of the Young-Helmholtz theory of colour-vision and colour-blindness. Trichromasy in normal eyes is not now theoretical, but a proved fact. Hering's theory, which is favoured by some investigators, is, as Helmholtz showed, also a trichromatic theory; and while both can account for the observed facts, the Young-Helmholtz theory is the simplest that can be formulated. Lack of recognition of its accuracy has been due to non-recognition of the fact of normal trichromasy; or to the erroneous supposition that it is tied down to any one definite view of the nature of the physical and physiological actions concerned in vision; or to the equally erroneous supposition that it can account for only one particular type of colour-blindness with merely individual variations. It can account for any type that is known, or for any at present unknown which may afterwards be found to exist, provided only that it arises from limitation of the at present known normal conditions.—Prof. W. **Peddie**: Note on the quaternionic system as the algebra of the relations of physics and relativity. The author showed that in all cases in which our observations are upon directed phenomena occurring in tridimensional space, but which are actually or merely descriptively to be regarded as influenced by the existence of that space in space of a higher order, the appropriate algebra to be used in their investigation is that of quaternions with the addition of the symbol of the space involved.

PARIS.

Academy of Sciences, February 2.—M. Henri Deslandres in the chair.—The president announced the death of Jules Boulvin, correspondant of the Academy.—C. **Moureu** and G. **Mignonac**: The dehydrogenation of the primary and secondary alcohols by catalytic oxidation. A general method of preparation of aldehydes and ketones. Finely divided silver deposited on asbestos was found to be the best catalyst, and the oxidation is carried out in stages, only about half the amount of air theoretically required for the full reaction being employed in the first stage. The results for nine alcohols are given; the yields are high—62 per cent. for formaldehyde and 70 to 95 per cent. for the higher aldehydes.—A. **Gautier**: The normal arsenic in living tissues and the traces of iodine found in air and waters. Some necessary corrections.—G. A. **Boulenger**: An extraordinary tortoise, *Testudo Loveridgii*. This tortoise is the first example of a reptile in the adult state without ribs, and is a unique case of normal osteolysis.—M. Chodat was elected a correspondant for the section of botany in succession to M. Flauhault, elected non-resident member, and M. Ch. Nicolle a correspondant in the section of medicine and surgery in succession to the late M. Lépine.—L. **de Pesloüan**: A congruence between Bernoulli's numbers.—P. **Idrac**: Study of hôvering flight in Upper Guinea.—M. **Romieux**: Alluvial strata of the Lot in the neighbourhood of Fumel.—L. **Brillouin**: The continuous spectrum of X-rays.—F. **Canac**: The determination of the axes of symmetry of a cubic crystal.—R. **Abrard**: A Mesoliassic fauna of Sidi Mouley Yakoub (Western Morocco).—F. **La Porte**: Atmospheric observations at Gâvre by means of free rubber balloons. The experimental results can be fairly well represented by Dines's formula with a modified numerical constant, $V=\frac{90\sqrt{F}}{(F+P)}$, where V is the ascensional velocity per minute, F the ascensional force, and P the weight of the envelope in grams.—L. **Emberger**: The evolution of the chondriome in the vascular Cryptogams.—L. **Daniel**: Antagonistic reactions and *rôle* of the pad in grafted plants.—M. **Bezssonoff**: Experimental sexuality in fungi, situated on the typical structure of the sexual plasma.—F. **Gard**: Division in *Euglena limosa*.—G. **André**: The inversion of saccharose in the juice of the orange.—E. **Hérouard**: Double monsters of the scyphistome.—C. **Gessard**: Pyocyanoid bacilli.

BOOKS RECEIVED.

The Topographical Anatomy of the Limbs of the Horse. By Dr. O. C. Bradley. Pp. xi+172. (Edinburgh: W. Green and Son, Ltd.)

Harmsworth's Universal Encyclopedia. No. i. Pp. xix+128. (London: The Amalgamated Press, Ltd.) 1*s.* 3*d.*

Index of Economic Material in Documents of the States of the United States. Pennsylvania, 1790–1904. Part i. By A. R. Hasse. Pp. 810. (Washington: Carnegie Institution of Washington.)

Index to U.S. Documents relating to Foreign Affairs. 1828–1861. In three parts. Part ii. By A. R. Hasse. Pp. 795–1331. (Washington: Carnegie Institution of Washington.)

British Journal Photographic Almanac and Photographer's Daily Companion, 1920. Edited by G. E. Brown. Pp. 912. (London: H. Greenwood and Co., Ltd.) 1*s.* 6*d.* net.

A Field and Laboratory Guide in Physical Nature-Study. By Prof. E. R. Downing. Pp. 109. (Chicago: University of Chicago Press; London: Cambridge University Press.) 1 dollar net.

Practical Pharmacology: For the Use of Students of Medicine. By Prof. W. E. Dixon. Pp. viii+88. (Cambridge: At the University Press.) 7*s.* 6*d.* net.

Chemistry for Textile Students. By B. North. Assisted by N. Bland. Pp. viii+379. (Cambridge: At the University Press.) 30*s.* net.

An Introduction to the Study of Cytology. By Prof. L. Doncaster. Pp. xiv+280+xxiv. (Cambridge: At the University Press.) 21*s.* net.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 26.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—A. H. Smith: Illustrations of Ancient Greek and Roman Life in the British Museum.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* L. F. Richardson: Some Measurements of Atmospheric Turbulence.—W. G. Duffield, T. H. Burnham, and A. A. Davis: The Pressure upon the Poles of Metallic Arcs, including Alloys and Composite Arcs.—J. H. Hyde: The Viscosities and Compressibilities of Liquids at High Pressure.—A. Russell: The Capacity Coefficients of Spherical Conductors.—C. Cuthbertson and Maude Cuthbertson: The Refraction and Dispersion of Carbon Dioxide, Carbon Monoxide, and Methane.—A. A. Griffith: The Phenomena of Rupture and Flow in Solids.

INSTITUTION OF ELECTRICAL ENGINEERS, RÖNTGEN SOCIETY, and ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section) (at Royal Society of Medicine), at 5 and 8.15 (Joint Discussion on Electrical Apparatus in relation to X-rays).—Dr. R. Morton: The Efficiency of High-Tension Transformers as used for X-ray Purposes.—Major C. E. S. Phillips: The Problems of Interrupted and Fluctuating Currents.—R. S. Wright: High-Tension Transformers.

COLD STORAGE AND ICE ASSOCIATION (at Royal Society of Arts), at 5.—H. J. Deane: The Development of the Cold Storage of the Port of London Authority.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. A. Castellani: The Higher Fungi in relation to Human Pathology (Milroy Lecture).

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Dr. W. E. C. Dickson: Some Pathological Aspects of Tuberculosis.

CONCRETE INSTITUTE (at Vauxhall Bridge Road), at 7.30.—E. F. W. Grimshaw: Reinforced-Concrete Fences and Posts.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, FEBRUARY 27.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 4.30.—Dr. Mellanby and Others: Discussion on The Influence of Accessory Food Factors (Vitamine) in Infant Feeding.

PHYSICAL SOCIETY, at 5.—T. Smith: The Balancing of Errors.—Dr. N. W. McLachlan: The Testing of Bars of Magnet Steel.—G. D. West: The Forces Acting on Heated Metal Foil Surfaces in Rarefied Gases.—Miss N. Hosali: Exhibit of Models of Crystals.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—F. W. C. Dean and Others: Discussion on The Education of the Engineer.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—R. H. Kenyon: Defects found on Inspection of Boilers.

WIRELESS SOCIETY OF LONDON (at Royal Society of Arts), at 8.—A. A. Campbell Swinton: Some Wireless Wonders (Presidential Address).

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.30.—Dr. M. Young: An Investigation into the Periodicity of Epidemics of Whooping Cough from 1870 to 1910 by means of the Periodogram.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—W. B. Hardy: Problems of Lubrication.

SATURDAY, FEBRUARY 28.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir J. J. Thomson: Positive Rays.

MONDAY, MARCH 1.

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND, at 4.30.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—R. H. Cunningham: Some Engineering Work done by the 277th Railway Coy. (R.E.) in France and Belgium during the War.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting) (at Chartered Institute of Patent Agents), at 7.—R. E. Dickinson: The Future of Labour in the Engineering Industry.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. Austen Hall: The Planning of American Departmental Stores.

ROYAL SOCIETY OF ARTS, at 8.—C. F. Cross: Recent Researches in the Cellulose Industry (Cantor Lecture).

SOCIETY OF CHEMICAL INDUSTRY AND FARADAY SOCIETY (at Chemical Society), at 8.—Dr. T. M. Lowry and F. C. Hemmings: (1) The Caking of Salts and Other Crystalline Substances. (2) The Setting of Dental Cements.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Lt. E. W. P. Chinnery: The Opening of New Territories in Papua.

MEDICAL SOCIETY OF LONDON, at 9.—Dr. H. R. Spencer: Tumours complicating Pregnancy, Labour, and the Puerperium (Lettsomian Lecture).

TUESDAY, MARCH 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. Keith: British Ethnology—The Invaders of England.

ROYAL UNITED SERVICE INSTITUTION, at 3.—Anniversary Meeting.

ROYAL SOCIETY OF ARTS (Colonial Section), at 4.30.—G. F. Scott Elliot: Trade Routes for the Empire in Africa.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. A. Castellani: The Higher Fungi in relation to Human Pathology (Milroy Lecture).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Lantern Meeting), at 7.—Miss Olive Edis: Women on Active Service during the War in France and Flanders.

RÖNTGEN SOCIETY (at Royal Society of Medicine), at 8.—Prof. W. H. Bragg: Analysis by X-rays (Silvanus Thompson Memorial Lecture).

WEDNESDAY, MARCH 3.

ROYAL SOCIETY OF ARTS, at 4.30.—W. J. Garnett: Mongolia from the Commercial Point of View.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 8.—Prof. B. Melvill Jones: Flying over Clouds in relation to Commercial Aviation.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—P. J. Worsley: Gears and Gear-cutting.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—C. Ainsworth Mitchell: The Detection of Finger-prints on Documents.—C. J. Ward: Photomicrography with Simple Apparatus.—R. V. Wadsworth: The Solubilities of Theobromine.

ENTOMOLOGICAL SOCIETY, at 8.—*Probable Paper:* G. J. Arrow: Sexual Dimorphism in Coleoptera (with lantern slides.)

THURSDAY, MARCH 4.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Lt.-Col. E. Gold: The Upper Air: (1) Modern Methods of Investigation, and their Application in the War.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 5.—Dr. A. B. Rendle, E. G. Baker, and S. L. Moore: A Contribution to the Flora of New Caledonia, based on the Collections of R. H. Compton in 1914.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. A. Castellani: The Higher Fungi in relation to Human Pathology (Milroy Lecture).

CHEMICAL SOCIETY, at 8.

FRIDAY, MARCH 5.

ROYAL ASTRONOMICAL SOCIETY, at 5.—(A Geophysical Discussion.) J. de Graaf Hunter and Others: The Earth's Axes and Figure.

CONCRETE INSTITUTE (at 296 Vauxhall Bridge Road), at 6.—E. S. Andrews: Some Properties of Steel.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at City and Guilds (Engineering) College), at 7.—Roger T. Smith: Presidential Address.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Hon. J. W. Fortescue: Military History.

SATURDAY, MARCH 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir J. J. Thomson: Positive Rays.

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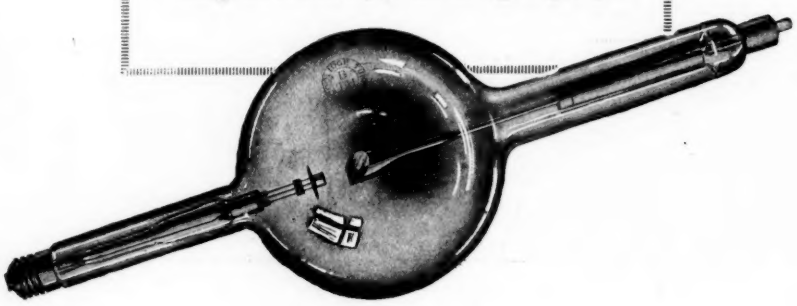

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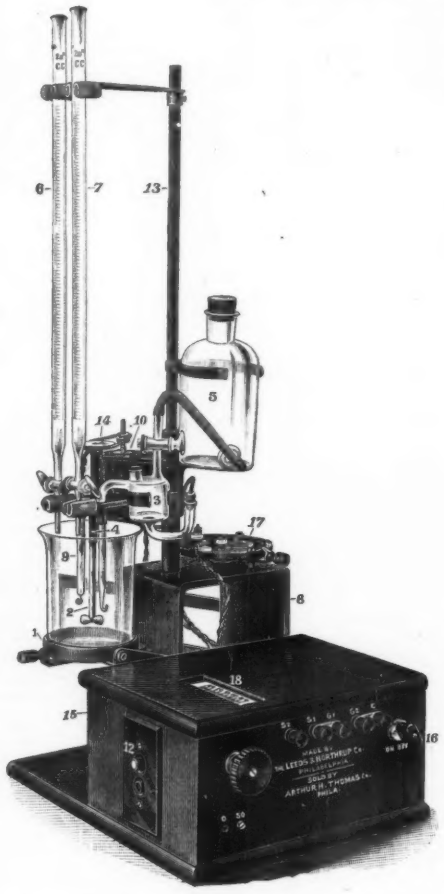

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XXVI.—Parametric Solutions for a Fundamental Equation in the general Theory of Relativity, with a Note on similar Equations in Dynamics. By E. T. BELL.

XXVII.—The Mandelstam Method of Absolute Measurement of Frequency of Electrical Oscillations. By J. TYKOCINSKI-TYKOCINER.

XXVIII.—Variably Coupled Vibrations: Gravity-Elastic Combinations. Masses and Periods Equal. By L. C. JACKSON, F.P.S.L. (Plates VI. and VII.)

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XXXIII.—On the Measurement of Time—a Rejoinder to Dr. N. Campbell. By L. SILBERSTEIN, Ph.D.

XXXIV.—An Attempt to Determine if Common Lead could be separated into Isotopes by Centrifuging in the Liquid State. By J. JOLY, F.R.S., and J. H. J. POOLE, B.A.I.

XXXV.—On the Effect of Centrifuging certain Alloys while in the Liquid State. By J. JOLY, F.R.S., and J. H. J. POOLE, B.A.I.

XXXVI.—Notices respecting New Books.

XXXVII.—Proceedings of Learned Societies:—GEOLOGICAL SOCIETY: Mr. H. HAMSHAW THOMAS on some Features in the Topography and Geological History of Palestine.

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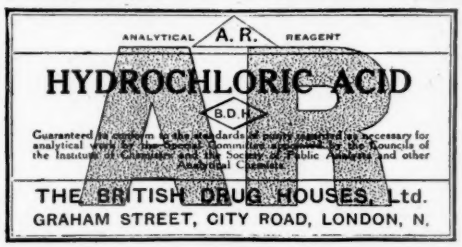
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